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U. S. FOREST SERVICE
OGDEN, UTAH

REPORT OF THE

NATIONAL FOREST TRAIL STUDY

1946 - 47.

H. M. SHANK., CIVIL ENGINEER,
E. R. DESILVIA., FORESTER,
U. S. FOREST SERVICE

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E
ROADS & TRAILS
Trail Studies

March 26, 1948

Circular - E-3308

Regional Forester
All Regions

Dear Sir:

A copy of this circular is attached to each copy of the Shank-DeSilvia report in order that it may be considered by all who have occasion to review the report. It should, of course, be called to the attention of all concerned with planning for or financing of trail construction, improvement, and maintenance.

The following points, in particular, we believe should get close attention and action indicated:

1. Replanning the existing and proposed trail system following the general pattern of the conferences discussed on pages 23 and 24 should be undertaken for all forests as promptly as practicable. From the combined experience to date, we believe all Regions should plan on completing the job by June 30, 1949. The strongest sort of emphasis should be placed on a cold-blooded, objective approach with a goal of the absolute minimum mileage in the system that will meet requirements. The fact that mileage of trail is existent is by no means prima facie evidence that it belongs in the system; that has been repeatedly demonstrated to be fallacious.

2. We had hoped that it might be possible to reduce the system by considerably more than is recommended in the report. Therefore the recommendation for a ceiling on existing mileage, Column 1, page 29, is to be used as a preliminary objective for the Region as a whole. Individual forests will often fall below the lines on the plates following page 26. It will be found illuminating to compare not only forests but individual ranger districts on the basis of combined road-trail intensity and to see how far they deviate from the recommended ceiling (red line) on the charts following page 26. Such comparisons have already proven extremely useful in showing up disparities not otherwise evident and, we hope, may result in your arriving at a regional mileage well below that indicated in the report.

3. It is our intention to allot trail maintenance funds on the basis of these findings just as far as appropriations permit. If that is impossible, allotments will then be made to Regions in the same proportion.

(Over)

2-Cir. E-3308-3/26/48

4. As the report points out, there is an unparalleled opportunity for more forthright, two-fisted management than now seems to be practiced on this particular activity. Perhaps this would go far to solve the insufficiency of funds. The recommendation on page 13 under "Centralization of Work" should be given a fair trial.

5. We urge that every man concerned consider to what extent the discussions on pages 8 to 16 apply to him, and what remedies can be applied.

Shank will visit western regions this summer. We want to cash in on the effort he and DeSilvia made and are depending on you to take all possible advantage of it.

Very truly yours,

LYLE F. WATTS, Chief

By

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(over)

Errata

Page 2, last line numbered paragraph 4, substitute "based" for "used".

Page 2, map on opposite page, fails to show symbol for 70 miles examined on Targhee.

Page 3, add under heading "Betterment":
(includes urgent deferred and preventive maintenance.)

Page 21, second word should be "tries" instead of "trees".

Page 21, third paragraph, third line after helicopter - substitute "or" for "of".

Page 24, map opposite should show Lolo in Group 2 instead of Group 1.

Page 31 of Appendix, under Group 5, eliminate "Harney .76 .01".

Ogden, Utah
January 15, 1948

REPORT

OF THE

NATIONAL TRAIL STUDY

1946-47

GENERAL

Authorization and Purpose

The authorization for this project is contained in the Chief's "E, ROADS AND TRAILS, General, Trail Studies" Circular E-3150 of March 27, 1946. The purpose of the study is

> "to examine critically the existing system to find out whether, in the light of present and prospective transportation facilities, it is what we need; if not, to develop examples or indicators of what is needed; secondarily to find out what the existing system is costing to maintain and whether the level of maintenance is adequate and reasonable in cost."

The national forest trail system has, in good measure, "grown up" over a period of 40 years or more. During that time no comprehensive nation-wide study or examination has ever been made. This raised not only the question of adequacy of the system, and proper allocation of funds but the question of what the system should cost to maintain versus what it is costing. Accounting records answer the last question without necessarily getting close to the other one. The detailed field examinations were designed to provide an answer.

Field work was begun on April 26, 1946, and ended October 25, 1947. Examinations were made on 5117 miles.

Sampling Method

With 145,339 miles of trails in the total system and two men to make the necessary examinations in two field seasons, using mostly primitive modes of transportation, one of the first concerns was to devise a sampling method that would yield dependable results.

Advice was sought from men who have been responsible for sampling methods on the Forest Survey, to which this job is analogous in some respects. James G. Osborne, Chief of the Section of "Statistical

Services", and Richard H. Blythe of the Section of "Requirements, Production and Supplies", Division of Forest Economics, gave invaluable advice and suggestions that have been used throughout the study with some changes to fit local situations.

The general method used was to:

1. Set up in each region groups of forests having generally similar characteristics as regards trail maintenance and roughly the same amount of trail mileage to the group. This was done by the region.

2. Classify the area of each forest as either easy or difficult as regards trail maintenance. The purpose was to insure examination of mileage in proportion to the amount that is easy and difficult to maintain, as classified by the persons best qualified to know. This was done by the region.

3. Select at random (by lottery) sample sections of trail to be examined on one forest in each of these groups. These samples at first were small and generally widely scattered geographically. Later as the work progressed into less accessible areas this proved to be impracticable and a continuous trip across a forest was substituted. This sampling was done by the examiner.

4. Make a field examination of each individual mile, jointly with a representative of the forest or region, or both, discussing and getting as nearly as possible a meeting of minds about the various things under consideration, but particularly what it should cost to maintain. Thus, the individual mile of trail was the ultimate sample. Mostly, distances were used on travel time.

5. Record the various data on code sheets that were later transferred to punch cards for handling in I.B.M. (See form in Appendix. The Code is shown in Appendix also.)

No serious question has been raised about the impartiality of this method of sampling and there has been general agreement that we got a good cross-section. There may have been a feeling at times that we were going to unnecessary lengths to do an unbiased job of sampling, although nobody suggested an improvement.

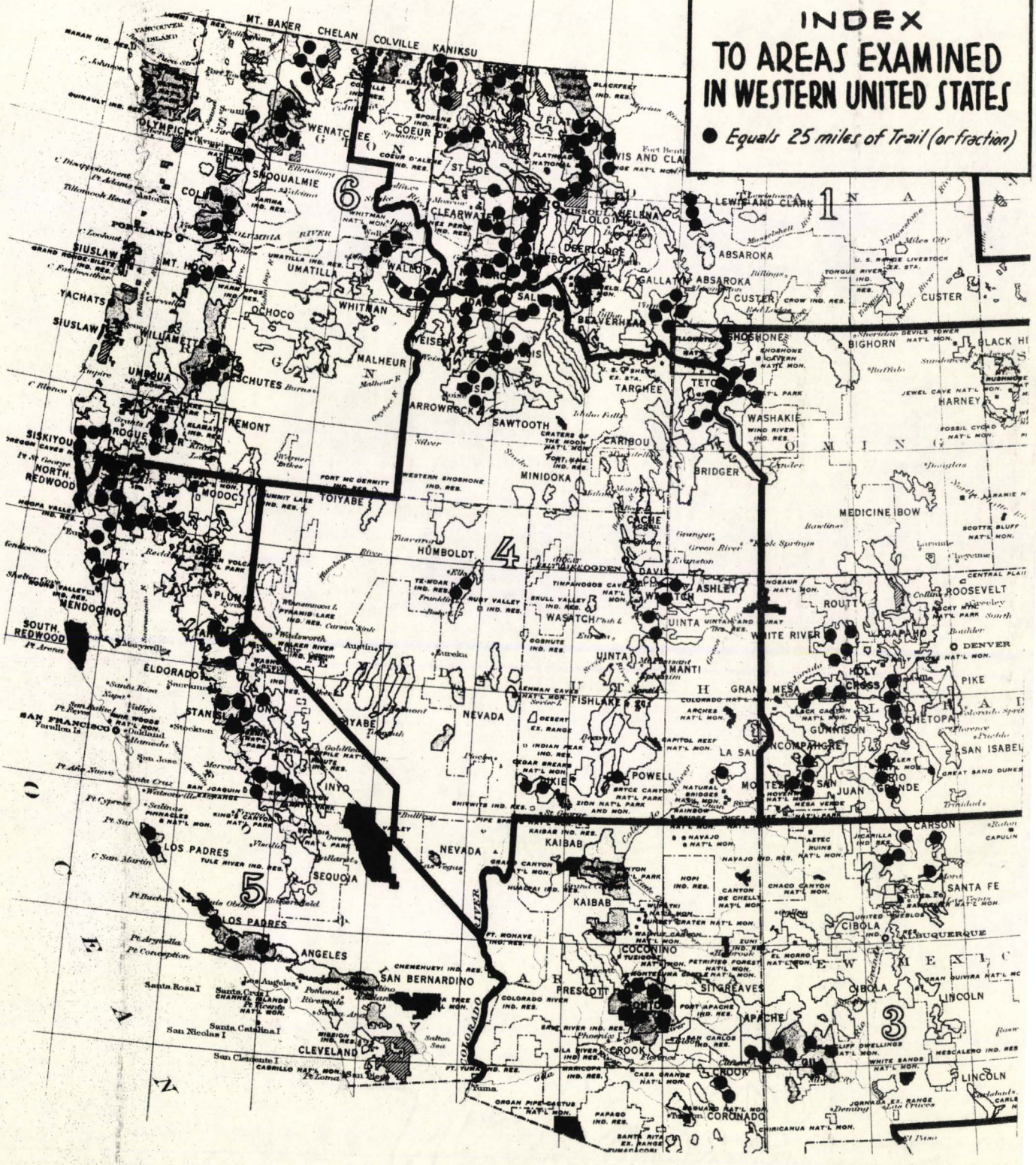
The code was intended to provide all data on the subject that would possibly be needed, and some questionable items were included, since no time of any consequence would be required to record them. Some items have not yielded anything of value while some have proved useful in wholly unexpected ways. Punch cards are on file in Washington and machine tabulations for any combinations of the coded data can be made on request by the regions, and will be found much simpler than hand sorting required data from the code sheets.

1946-47 TRAIL STUDY

INDEX

TO AREAS EXAMINED IN WESTERN UNITED STATES

● *Equals 25 miles of Trail (or fraction)*



1946-47 TRAIL STUDY
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TO AREAS EXAMINED
IN EASTERN UNITED STATES
● Equals 25 miles of Trail (or fraction)

II CURENT CONDITION OF THE TRAIL SYSTEM

The current state of maintenance of the trail system is bad everywhere. From 1942-46 inclusive little was done except to cut out the bare minimum of wind fall to make trails passable and not always that. Drainage, tread work and brush got substantially no attention and now represent a big reservoir of work that must have attention.

Noteworthy progress was made in spots in 1947 - there just was not nearly enough of it.

A brief statement on the general condition of the system as regards original construction standard, required betterment, deferred and preventive maintenance is necessary to understand the estimates of annual maintenance costs which are affected by all of these.

We agreed on the following order of rating of regions for construction standard: 6, 1, 9, 5, 2, 3, 4, 8 and 7. Trails in both Regions 6 and 1 were constructed to a uniformly high standard, but there is a large mileage of way in both regions with standard so low that it can often be recognized as a route only with some difficulty. There is no important difference in conditions in Regions 9, 5, 2 and 3 except that, in general, standards grade downward. Regions 4, 8 and 7 in that order are far below the other regions in this respect as far as our observations went, a major part of the system qualifying as no better than a way and often a very poor one at that.

A condition of this sort raises a question of what betterment should be done. We believe none should be done on "ways" except to make them reasonably safe and to prevent excessive erosion. For the rest of the system, our estimates here make no distinction between betterment, deferred and preventive maintenance or rather these items are lumped. They provide for nothing beyond barest necessity and probably are ultra-conservative and are for a trail of the present standard width of 16" - 24". They nevertheless are a very considerable item. We see no possibility of ever catching up with this back log of work unless some special dispensation of funds is made. The estimate follows:

	Betterment	
Region	Est. Cost per mile (all mileage)	Percentage of mileage requiring no betterment
1	$ 7.55	85.5
2	25.09	31.5
3	22.14	78.6

Betterment (cont'd)

Region	Est. Cost per mile (all mileage)	Percentage of mileage requiring no betterment
4	22.91	37.9
5	27.98	72.9
6	19.46	56.0
7) 8)	4.74	) 89.3
9	--	--
Averages	18.35	65.2

(Note: These figures, as well as others herein, do not agree exactly with the preliminary report. This is due to corrections available from machine runs; to better data on indirect costs and other factors.)

III MAINTENANCE

Estimated Maintenance Cost

Although maintenance of the trail system and its cost is a secondary objective of this study, it is discussed first in this report, because some of the data collected for this purpose are necessary for intelligent discussion later of the primary one - what trail system is needed.

The detailed examination of trails selected at random to give an impartial cross-section of the regional maintenance job yielded an estimate as follows: (See Appendix for a detailed breakdown of these figures.)

Maintenance Estimate - Per Mile

Region	At Uniform Wage Scale of $1.15 per hr	Adjusted to 1947 Wage Scale
1	9.96	9.96
2	6.98	5.51
3	7.35	5.54
4	7.33	7.06
5	10.88	10.25
6	11.20	11.04
7	6.14	5.16
8	6.53	4.75
9	12.57	9.93

Labor originally was calculated at $1.15 per hour, which approximates the weighted average pay for trail workers in western regions but is materially higher than the average for Regions 2, 3, 7, 8 and 9. The cost estimate adjusted to reported 1947 wage scales is shown in column 3.

A Comparison of Examiner and Forests Estimates

In nearly all cases a representative of the forest or the regional office also made an estimate of "on-the-ground" work, usually after discussion. A record of these estimates was kept in the code sheets in the same manner as the examiners' estimate. The estimates by regional representatives in 1946 were significantly higher in Regions 3 and 5 than ours (7% higher in R3 and 17% higher in R5). Whether we became conditioned by these experiences or whether other regions are more conservative, it is impossible to say, but the differences between our estimate and local forest officers in the other regions were so small they may be neglected. The feeling has been freely expressed that if funds became available in the estimated amounts and proper management practices are put into effect, it will be possible to get on top of the maintenance job.

It should be mentioned that many officers are inclined to include deferred - preventive maintenance and betterment as a part of annual maintenance.

Cost of betterment would be much higher in Region 1 except that it is our belief that possibly several thousand miles of low standard "way" requires not betterment but elimination from the system. There was never more than a nominal investment in them and there is really nothing to start from to do a betterment job.

The same situation exists in Regions 3 and 4 but to a less extent and limitedly in all regions.

Actual Cost of Maintenance

Total allotments for maintenance during the war years and subsequently were as follows:

Region	Trail Maintenance Allotments per mile			
	Fiscal Year			
	1942	1943-45	1946	Average 1942-46
1	$5.14	$5.46	$5.69	$5.49
2	2.40	3.61	3.57	3.36
3	2.05	3.13	4.46	3.18
4	1.54	2.90	3.60	2.77
5	4.06	8.80	9.94	8.10
6	3.92	4.70	6.63	4.93
7	4.56	5.22	5.93	5.23
8	2.41	1.74	3.22	2.17
9	2.18	3.00	5.54	3.34

Probably no region kept up with the job in 1946 (year of highest average), although allotments were substantially greater than during the war years. There was evidence that an inadequate job was being done at least in part in all the regions where examinations were made in 1947. The job was wholly inadequate in

Regions 2, 4, 7, 8 and 9 despite the 1947 increase in allotments. Rangers who were questioned about how much of the system would be maintained in 1947 reported from 20 - 40%, but this fails to give a clear picture of the situation, since on most districts the job is done on a rotation basis. If, for example, the rotation is at three-year intervals, it would be expected that only about 1/3 would be done each year. However, much of it consists of little more than cutting out windfall that cannot be by-passed and this is often the small part of the job.

The best estimate we can make as to adequacy of maintenance funds at present is the ratio of expenditures to our maintenance estimate adjusted for regional wage scales. This indicates funds sufficient in 1946 to accomplish to a satisfactory standard the following percentages of the system:

Region	Percent of System that can be maintained with 1946 allotments*
1	57%
2	65
3	80
4	51
5	97
6	60
7	115
8	68
9	56

*1946 expenditure divided by maintenance estimate.

We take this to mean that if there were no more than normal deferred maintenance and each region's continuing annual expenditures were at the 1946 rate, they could keep in satisfactory condition only the percentage of the system shown. The remainder of 100% of the system would get no maintenance whatever if our estimates are correct.

Current Costs in Terms of Prewar Dollar

In the preliminary 1946 report, it was estimated that the cost of trail maintenance had increased about 32% since 1941. This was arrived at simply by comparing wage scales and applying proper correction factors for percentage of the cost going for labor and for differences due to the 40-hour week. It so happens this agrees almost exactly with the Department of Commerce Consumers Price Index which was 105.2 in 1941 and 139.3 in 1946 or if 1941 is considered at 100, the 1946 index would be 132.4.

However, this situation has been changing at a rapid rate since January, 1946 and as of July, 1947 this index stood at 158.4. It

is materially higher at the time this is written (January, 1948). Not only has this index shown a marked increase, but figures on equipment operation and repair, an item of consequence in trail maintenance, has as a weighted average increased at least 60% and on some categories more than 100%. As an up-to-the-minute guess, Fiscal Year 1942 costs would have to be increased by 75%, at a minimum, to meet 1947 needs. We then have the following comparisons:

Region	F.Y. 1942 allotments per mile	1942 allotment increased by 75%	1947 Estimate
1	5.14	9.00	9.96
2	2.40	4.20	6.98
3	2.05	3.59	7.35
4	1.54	2.70	7.33
5	4.06	7.10	10.88
6	3.92	6.86	11.20
7	4.56	7.98	6.14
8	2.41	4.22	6.63
9	2.18	3.82	12.57

The question may well be asked why 1947 estimates are higher than prewar allotments after having applied a correction factor to them for the devalued dollar. The answer is that trail maintenance allotments never have been adequate to do the job properly. In general we have never done much more than cut out windfall and not always that.

The spread in some regions between Columns 3 and 4 in the preceding table is at least partly explained by the amount of deferred and preventive maintenance to be done.

Lack of funds by no means fully explains the present condition of the trail system. Some of the other reasons are discussed together with suggested remedial action in the following paragraphs.

Reasons for Present Condition of the System

This is our size-up of the factors chiefly responsible for the present unsatisfactory condition of the trail system with some suggested remedies. Some of it is so trite we dislike to state it. It is our considered opinion, and concurred in by many field men, that no job in the Service is being done quite as haphazardly as trail maintenance. This is pointed up by the occasional individual who with no more than average resource is doing a first class job. As will be seen, the fault lies at all levels. The diagnosis follows, arranged in the sequence they should be acted upon rather than in importance.

Attitudes

There is a marked difference in the efficiency and quality of trail maintenance work from district to district. Much of the difference seemed to spring from the differing attitudes of the men responsible for the work. We found district rangers who took the facilities at hand and did their best with them. We also found men with a defeatist attitude, complaining that they couldn't get good men, men didn't know what to do, men wouldn't do what they were told, funds were too short, and there was nothing they could do about it.

After finding both good and poor work on comparable (sometimes adjoining) districts or forests with equal facilities, we believe the cultivation of a militant positive attitude will go far toward correcting the unsatisfactory situations. Any organization takes its tone and tempo from the man at the head of it.

Working Conditions

Wages must be kept at a level comparable to other local employment. This refers to net wage, i.e., unless we pay somewhere near the same wage for a calendar week of work as other employers, it is obvious we will get an inferior grade of employee who from a production standpoint will be about the poorest obtainable.

Travel time on the job, under optimum conditions, cuts into productive time unreasonably. This requires careful scheduling and constant checking to get a reasonable day's work. There is no uniformity in the requirements between regions or even within the same region. It is tied in with the troublesome problem of housing crews. Cabins should be provided so that crews are never required to walk more than about 5 miles from a camp site (or from a road). These should be small, primitive in character, but providing protection from the elements, insects, and marauding animals. A sketch of such a cabin is shown in the appendix. The required number after eliminating trail mileage within 4-6 miles of roads and within a similar range of existing cabins, lookout houses, etc., will be found quite modest. Even though regulations prevent the use of road funds for constructing buildings except for storage, this would pay dividends in the long-run in better morale of employees, savings in time moving camps, wear and tear on tentage and the like.

A rough cabin such as we have in mind will now cost upwards of $1000 or from $.50 to $1.00 per mile per year for the mileage of trail that would be maintained from it. This is several times the cost of tentage but aside from the effect on morale and working conditions they would be available for other activities which would narrow the gap in cost between them and tent camps.

Everything within reason should be done to allow employees advantages of family and community life. Permitting work for ten straight days, followed by four days off, is one legal way of doing this and would meet one of the objections to employment in remote areas.

Continuity of employment or at least a maximum degree of security would go far to solve the problem of excessive turn-over. The over-all trail maintenance job is big enough that, despite a maximum field season of 6-7 months, with careful planning a few trail employees on most forests could be given a job that would support them and in which they could take some pride of proprietorship. Even if they did relatively low priority work for two or three months annually, this would still be a paying proposition. In some cases it would require consolidating this class of work between two or more ranger districts or even all the work on a forest.

Selection

Some degree of selectivity in choosing employees will be possible if we first do all that is reasonably possible to make the job and the factors surrounding it attractive. As it is now, we are mostly seeking employees, when, if conditions were wholly right, they should be seeking the job. Good trail workers conform to no set pattern. Energy and physical fitness are prime requisites, yet we have seen flagrant violations of both points. Most work will continue to be done by 2 or 3 man crews. The leaders of such crews obviously should be old enough to have some stability and can hardly be expected to produce if burdened with immature boys interested chiefly in a pay check. In addition, there are possibilities of hiring man-and-wife combinations and of making local dependents responsible for all the trails in a specified area on either a day or contract basis.

Plans

A lack of simple working plans seemed to us one of the most important reasons for the condition of the trail system. It is distressingly common to find ranger districts with no plan whatever (except that in someone's head) and many so-called plans are nothing more than a statistical record of existing mileage. Our policy of shifting men often is alone sufficient reason for making a written plan which may be passed on to a successor. It was rather common to be told by rangers, "I'm sorry but I'm new on the district and have no very definite information about the condition of the trail system". There could be no harsher indictment of a predecessor even though it was not so intended.

Training

A simple training device that needs wide application is selection of a section of trail of sufficient length to have a variety of conditions

and putting parts of this rather carefully into the shape it should be in contrast to adjoining sections left in the shape it is so often found to be.

This would supply a sort of show window of how work of clearing, brushing, grading, backsloping, rock slides, retaining walls, drainage, sign posting and so forth should be done. Each section might even be posted with a brief write-up of the points intended to be emphasized. With a half day or less spent on such a demonstration section impressing the members of a crew, any additional training should be on-the-job and incidental to regular trips of inspection and supervision.

Methods

(a) Hand Methods

Methods of trail maintenance have changed very little in many years and as long as trails are a simple, primitive means of transportation, this will probably continue. This should not preclude the use of a more efficient tool if available. We find men still talking of the cost of grading trail by hand, when the grading should be unquestionably done by plow and horse or possibly tractor. Clearing windfall can be done at less expense with power saws if there is any considerable and more or less continuous volume of work. At the same time we need to know from actual experience where the ratio of travel to work time makes the use of such equipment more expensive than hand work. We suggest some time studies, particularly in the insect-killed timber of the interior west. A week of detailed performance records under nearly identical conditions would answer some questions that cannot be answered with certainty in any other way. For example, a 2-man hand-saw crew could make cuts on alternating windfalls, another crew with power saws cutting the remaining trees. With samples selected so as to get a varying intensity of work, it could quickly be shown where each method is most effective. A record of the expenditures of time for auxiliary services would be required also, of course.

Plowing and grading by horse-drawn equipment (as distinguished from tractors) is considered hand method. From jobs observed in the field, we believe the Quillan trail grader to be much superior to the Beatty in terms of both quality and amount of work accomplished. Under favorable soil conditions a good grading job can be done almost at the rate of walking time of a plow animal.

Mechanical Methods - Tractors

The Clark-Air tractor has been used considerably to construct, better, and maintain trails and the R-6 developed Bettle tractor was put to work in several regions in 1947. We saw only a limited amount of this work (it was quite limited in amount) but from what we saw and have been able to learn, we are distinctly pessimistic. A few enthusiastic reports have been made, of which some of the projects were of such a nature they required no grading or the grading could have been done for less cost with a horse and plow.

This should be qualified with the important point that we continue to think of a trail as a primitive transport facility. If we seriously need or require a trail two or three times the width of accepted standards (16"-24") with a volume of work correspondingly increased, then it is probable that some mechanical device is the proper tool to use. We have no evidence that trails of this increased width are necessary except for a relatively small part of the system.

In an attempt to get at what part this would be, we eliminate (from the mileage we examined) (1) all mileage with side slope of less than 30%, standards now providing no graded tread on such trails (we do not agree entirely with that, as volume of use is a better indicator of need for grading, but that nevertheless is the standard), (2) out of the balance, all mileage classed as rock construction, on the ground that we would find the cost prohibitive to widen this mileage to 3½ or 4 feet solely to make it possible thereafter to maintain it mechanically; (3) out of the balance, all mileage with use of less than one animal or person every 4 days on the average, on the ground that benefit would be wholly disproportionate to cost. Having made these eliminations there remained the following estimated percentages of the system which it it appeared might or should be done with tractor:

Region	Percent of System appearing suited to tractor maintenance
1	14.7
2	7.4
3	5.4
4	9.1
5	20.7
6	18.2
7&8	8.4
9	Not available

It is our guess this estimate of mileage is too high rather than too low. We still have rather limited cost data on Bettle betterment and substantially none on maintenance. We find no one who seriously thinks that of the trails we would better and maintain with tractor, the initial cost will be less than $75 per mile on the average. There is a strong probability it will be very much higher, because there is almost no experience yet with betterment of sections involving a lot of rock, which is sure to shoot costs up outrageously. Even if there is not a penny of maintenance cost for the next ten years we will have spent at the rate of $7.50 per year for those ten years to get trails in condition so they can be maintained. That is higher than the national average cost per mile for maintenance now, and a maintenance job of some magnitude would still be to do.

On the basis of observations and data at hand, we believe the only possible selling point for the tractor is whether maintenance costs by hand-grader-mule methods can be reduced. If they can they should

be put into use. The issue should not be obscured by the argument that a tractor trail will be much higher standard. Comparisons should be made on the basis of a facility that meets requirements. If the present standard of 16"-24" width does so, then any additional width to accommodate a tractor is simply a frill and a luxury.

The system will require virtually doubled width in order to use Beetle tractors and the auxiliaries to it. It is estimated that a bridge will be required at intervals of 7 miles in Regions 1, 4, 5 and 6 to cross streams that cannot be forded with the tractor. These alone will be items of major cost. Assuming these jobs done it will be necessary to do three major phases of trail maintenance by other means, viz., cutting out windfall, brushing and drainage, and drainage structures. Grading is actually a minor part of the maintenance job in probably every region.

We believe that tractor maintenance is going to cost much more than hand methods and that we had better get down to earth selecting projects that because of heavy use and servicing large areas can be expected to be eligible for this class of maintenance. We had also better make a sufficiently critical analysis of tractor maintenance as we go along to insure that we are using the correct method.

Brush Cutting Devices

There is more urgent need for an effective inexpensive mechanical brush cutting machine than for a tool to work on trail tread. Brush cutting is the biggest single item of maintenance from Glacier Park to the Pacific Coast and down the coast and Sierra Nevada ranges to lower California. An effective tool (either a mechanical saw or clipper) is in sight that offers hope of being what we want. It is sure to be expensive (motor, generator, etc.) but can be kept to portable size in all probability. There is no assurance that work can be done cheaper than by hand, but the clipper is worth trying and a model should be available in field season 1948. The trouble with this and other mechanical gadgets is that the time spent in servicing them and moving them around is alone often enough to do the job by hand. The lighter the volume of work per mile, the more evident this becomes.

Chemicals likewise are available to kill or stunt the growth of brush. The cost of application, it appears, will be as much as brush cutting in many cases, to which must be added the considerable item of cost of chemicals, transporting it, etc.. No chemical treatment is now known that will completely destroy plant life and keep it from coming back. Even a complete kill is difficult to get and unreasonably expensive. Anyone who has had experience with destroying dandelions in lawn knows something of the cost aspects of such a job applied to the 20,000 miles of trail situated in more or less

continuous brush cover, not to mention at least that much more mileage on which brush is non-continuous.

The California Forest Experiment Station has a project under way, the results of which may supply an answer directly to our problem. In the meantime no other agency seems to have learned anything that bears directly on it which we can put to use economically at present.

Centralization of Work

Most forests operate their trail maintenance program on a decentralized basis. The mileage on many ranger districts is not great enough to make a real job. The size of the maintenance allotment therefore leaves the ranger with a sense of frustration as to how he can recruit, train and organize a crew for the short time he can finance them. This suggests the advisability of centralization where necessary to make a job of trail maintenance.

The following table is a classification that throws some light on the matter:

Number of Forests° by Miles of Trail per Ranger District

Region	Miles of trail per district (average)								
	0-50	51-100	101-150	151-200	201-250	251-300	301-350	351-400	Over 400
1		2		2			2	3	8
2	3	2	3	4	2	3			
3		3	1	4	3	1			
4	1	2	6	2	2	2	4	1	
5	2	1	2	2		5	3		2
6	1	3	1	3	1		5		5
7		1	2	3					
8	1		1	2					
9		1							
Total	8	15	16	22	8	11	14	4	15

°Only forests with a trail system are included.

If we assume that estimates of annual maintenance herein are reasonably reliable; that as much as 75-80% of the maintenance allotment will get to the ranger; that crews should work a minimum of three months annually and that a three-man crew will cost about $500 per month, then the number of forests with a trail maintenance job too small per district to qualify, is as follows:

Region 1 - 4	Region 4 - 13	Region 7 - 6
2 - 14	5 - 5	8 - 4
3 - 11	6 - 5	9 - 1

or 63 out of 113 forests where either consolidation of the work on two or more districts is indicated or rotation of the work on a single district at intervals of two years or more is an alternative. The latter is more economical and preferable if windfall presents no serious problem and brushing and other current maintenance can be deferred for two to four or five years. Regions 2, 3 and 4 particularly could well give more attention to these two alternatives.

Funds

There are probably some serious inequities in the relative amount of funds allotted to forests and to ranger districts. This situation should be reviewed by both regional office and supervisor to see that justice is done.

The complaint is widespread that funds are allotted on a too-short term basis. Instances were reported where trail funds are allotted on a quarterly basis. The practice of withholding funds until near the end of the fiscal year is common, with pressure to expend in June with resulting inefficiencies. Rangers are not given nearly enough authority and responsibility in financial planning, if our contacts have been typical. We were told of practices that sound incredible such as directions to the ranger to "do whatever is necessary (in trail maintenance) and we will pay the bills or let you know when funds are running short." This is, of course, a flagrant violation of a fundamental principle of management.

The estimates herein have been made on the basis of what can be expected of the average worker. They will prove inadequate unless improvements are made in the respects discussed and where they are applicable. Even though trail maintenance is a simple thing, comparatively easy to estimate and assess the cost, time studies under controlled conditions would be invaluable and may be necessary to set up standards of performance.

Standards

Are believed to be higher than is necessary in several respects, chiefly the following:

a. Grading in certain types of soil that supply good footing and that are at the same time highly erodable with the cover removed. Trails that carry any pack string travel of consequence should conform to existing grading requirements.

b. A maximum grade of 10% can well be increased to 15% for trails with light use. This applies particularly to trails in brush, timber or other ground cover which acts as a retardment to heavy run-off and erosion.

c. The requirement of a berm on graded trails is impractical, desirable though it may be.

d. The standard of 8-foot clearing for brush is satisfactory but actual clearing widths often exceed this greatly. This not only requires extra and unnecessary work but the opening up of a wide strip to sunlight speeds up regrowth. Holding to 8-foot width and trimming the trail side of heavy brush and saplings is a better procedure. A wide clearing also frequently results in a badly undulating grade as it allows more latitude within which horses may walk.

e. Standards should caution against "sandpapering" of all kinds. Too much of it now.

f. The standard of existing trails should not be bettered at the expense of maintenance funds.

Some or all of these points presumably will be resolved in a revision of the trail handbook.

Competition

There is nothing better than friendly rivalry to develop pride in work well done. Yet we found little evidence of a competitive spirit anywhere. We believe an effort should be made to develop it, between trail crews, between ranger districts, and between forests; and that it will stimulate interest and increase output of work. Competitive interest and spirit could be developed by reducing the quantitative and qualitative measure of the work done by various crews or ranger districts to a numerical score which would reflect the comparative standing of the competitors.

Contracting trail maintenance can be used as a stimulant for force account crews in the same way. It is appropriate to suggest that we proceed with caution to insure that contract prices are reasonable. The method is not fool-proof and is neither a cure-all nor a substitute for vigorous management of force account crews. Supervision of this class of work is sure to be greater than for force account work.

Supervision - Inspection

There is general agreement that trail maintenance is conducted about as ineffectively as any job we do. Some of this is due to lack of interest from the Chief's office to the district ranger. If we are serious in our intentions to have a good serviceable trail system, it will be necessary for the Washington Office to obtain an "on-the-ground" check of the situation each year. The Chief's Office should select forests at random in each region for inspection. The inspecting officer should get off the roads into enough back country to insure getting a cross section. Regional offices should inspect most forests annually and forest supervisors should take a more than cursory look at each ranger district. If we can get the district ranger back onto the job of periodically giving the trail crews on-the-ground inspection of a constructive nature, much will be accomplished. At the present time much of our money is wasted because little or no supervision is given after the ranger "turns crews loose".

When we get an insistent query of "why are trails in poor condition?", we are going to get an improvement without a cent of increased expenditures.

The level of expenditures for this work certainly appears to suggest a minimum of the following effective inspection time:

Washington - 3 days per year per region (western)
Region - 2 days per year per forest.

The wide variations in mileage by forests and ranger districts precludes any generalized recommendation at this level except that maintenance crews should be inspected at least once in two weeks by ranger, assistant or improvement foreman.

Miscellaneous

Damage to trails by livestock amounts to considerable in Regions 2, 3, and 4 and less in the other western regions. It is a rarity when stockmen are required to repair such damage. The responsibility should either be recognized and they be required to do the necessary work or the damage should be accepted as a necessary by-product of grazing.

Sign policy has called for heavy, expensive and expensive-to-maintain trail signs. Heavy routed signs seen extensively in several regions are probably costing at least four times as much as the simple aluminum sign illustrated in the appendix. These are recommended for all trail signs off road, and do not even require board backs provided the radius of the tree is as much as 2/3 the length of the sign. Posting without board back has at least two advantages, first there is less chance of sign being pulled down by snow and second less chance of damage by bears.

The machines now owned by Regions 5 and 6 are quite adequate to supply service-wide needs and the weight of the sign material is so light that transportation charge is negligible. We recommend the R-6 machine with letters 1/2" high in preference to the 3/4" letter produced with the R-5 machine which permits only a single line to a strip of 2" aluminum.

IV THE PLANNED SYSTEM

The Current Situation

The existing system according to the road and trail progress record on March 1, 1946 consisted of the following:

Region	Gross Area* (Sq. Mi.)	Miles Existing Trail	F.D.	F.H.	Road and Trail
1	43,480	37,152	10,595	1,655	49,402
2	34,162	15,977	7,709	2,360	26,046
3	34,384	12,391	18,673	1,721	32,785
4	51,084	26,957	8,324	2,029	37,310
5	35,614	20,299	17,540	2,180	40,019
6	42,460	26,350	16,018	1,884	44,252
7	14,604	4,205	3,018	2,725	9,948
8	29,469	954	10,281	4,089	15,324
9	24,101	948	8,178	3,641	12,767

*N.F. land June 30, 1946

The road and trail system per unit of area:

Region	Miles per sq. mi. (existing) Trail	FD	FH	Road and Trail
1	0.85	0.24	.04	1.14
2	0.47	0.23	.07	0.76
3	0.36	0.54	.05	0.95
4	0.53	0.16	.04	0.73
5	0.57	0.49	.06	1.12
6	0.62	0.38	.04	1.04
7	0.29	0.21	.19	0.68
8	0.03	0.35	.14	0.52
9	0.04	0.34	.15	0.53

Errors in the estimate of mileage

Most of the mileage in Region 1, about half of it in Region 6, and a small amount in Region 5 has been measured. Elsewhere the statistical mileage is almost wholly dependent on estimates. With very few exceptions, mileage estimates are too long by 5% at a minimum and possibly as much as 20% on some forests.

There is outlined in the appendix a method of measuring carefully selected samples of the trail mileage which was tested in 1947 on a forest of about average rough terrain and with a map of average accuracy. Six and one-half percent of the system was measured on the ground and carefully scaled map distances were checked against these measurements. Analysis of the data for this forest indicates

accuracy within 8% which is probably more than can be tolerated for a single forest. However, by measuring 6.5% of the mileage on all the forests, it is indicated that the error of estimate for a region will be less than 1%.

Regions should be required to measure enough to insure that estimates of the total are correct within, say, 2½%.

Many instances have been found of two forests reporting duplicating mileage of trail on inter-forest boundaries. Such duplications may total more than 1000 miles. A careful check of plan maps would correct this.

Criteria of Trail Need

For some time there has been a suspicion that the trail mileage figures were none too realistic and that they were inflated - possibly grossly so in some places. This suspicion was based to a considerable extent on the fact that hundreds if not thousands of miles of trail had largely disappeared if it ever existed, as such, in the first place. Therefore, the primary purpose of this investigation was:

> "To examine critically the existing system to find out whether, in the light of present and prospective transportation facilities, it is what we need; if not to develop examples or indicators of what is needed----".

We went into the examination with rather hazy ideas of what criteria of trail need might be developed, but distinctly with the idea after the first field season that we were carrying a lot of mileage that was little more than a statistical record. We got few suggestions from field personnel, they being as short of ideas as we were.

Judgment Estimates

We got judgment estimates from all the people who participated in these examinations and these estimates invariably were that, first, percentages of the existing trail system varying from 5 to 40 could be eliminated and, second, that very little non-existing mileage needed to be constructed, the later despite the fact that the progress record showed 17, 103 miles non-existing. There was pretty general agreement that eliminations could be made at least equal to the reported non-existing mileage and that reported non-existing mileage could be reduced by half. For whatever it was worth as an indicator, this looked like a reduction of about 12% of the existing system at a minimum and half that of the non-existing system. We have doubtless been influenced some in our thinking by the repetition of the same figures by so many people.

We investigated tentatively the effect of topography, fire load, cover (or fuel) types, lack of maintenance, benefit-cost ratios, and road-trail intensity in combination.

The difficulty with the first three is that they are complexes rather than specific conditions as they affect the intensity of a trail system and taken in combination this is even more pronounced. Except in a broad way, we found no relationship between any of the first three and road or trail or road-trail intensities, due doubtless to the fact that both facilities serve general areas rather than an area that can be described sharply in terms of one of the first three.

Lack of Maintenance as an Indicator

It seems fairly certain that if any trail is considered to have much importance, an earnest effort would be made to maintain it in usable condition, yet we saw a lot of mileage that had not been touched for years -- some of it possibly not since the trail was built. We were told of instances in which the ranger knew positively that no maintenance had been done for 10 or more years. None of these cases can be explained away by lack of funds, although the fund situation may have had some bearing on the overall standard of maintenance.

A record was kept of all mileage which in the field examination was shown to be non-existent or virtually so, or that had had no maintenance for an extended period of time. The total by regions follows:

Region	Total Miles Examined	Miles Non-existent or not Maintained for Long Period°	%
1	1259	71	5.6
2	502	51	10.2
3	481	123	25.6
4	822	112	13.6
5	779	62	7.8
6	829	56	6.8
7	201	46	22.9
8	193	37	19.2
9	51	0	0
Total & Average	5117	558	10.9

°Does not include small or isolated sections of trail--only whole projects or connecting links. The figure would be more than doubled if isolated sections were included.

Use - Benefit-Cost Ratios

In the appendix is shown a two-way classification by regions of all trails examined, by cost per mile to maintain and against this, the benefit in evaluated savings of time in trail travel versus cross-country. This shows an astonishing mileage of trail with almost no use, yet maintenance cost may be half as much per mile as the cost of maintaining the average mile of road. The argument is that these trails are needed for fire and that although this need may

include no more than two or three trips per year, when they are needed they are needed urgently and the prevention of a single fire of any size once in 10 or even 20 years will more than pay all the cost of the trail. However, practically all of this light use is foot travel of smoke chasers and even though the validity of the argument may be admitted, the situation does not necessarily call for a high class trail. Quite possibly a marked route would serve adequately as a point of orientation for the expected user on which there would need to be substantially no investment and no annual maintenance. From the standpoint of priority of funds this may be the sensible solution. Whatever the correct solution may be, by balancing annual maintenance cost against evaluated savings of time, we have indication that the following percentages of the trail system may be suspected of "buying" less than they are costing in annual maintenance:

Region	Percent
1	31.7
2	2.6
3	17.6
4	6.0
5	28.5
6	23.2
7	9.1
8	9.1
9	--

Topography

Regarding topography it is worth noting that from region to region there is not nearly the difference that might be suspected. Topographic maps were consulted for the total rise and fall per mile along odd or even degrees of latitude and longitude, depending on the location for which maps were available, getting a sample as far as possible without bias. The regional indexes for topography (roughness of terrain) thus developed from more than 1000 miles of profile, are:

Region	Topographic Index
1	1054
2	886
3	467
4	1142
5	794
6	1201
7	938
8	825

The low index for Region 3 can well be kept in mind when considering the final recommendations for ceilings on regional totals.

Fuel Types

Preliminary trees at relating road-trail intensity to fuel types appeared promising and it is probable that within a single region there is a significant relationship from forest to forest. Such a relationship does not hold true between regions, as far as we were able to determine, and for the reasons that (a) fuel type mapping (where it was done) does not conform very closely to the original definitions or descriptions, (b) the translation of fuel types into travel time requirements (and therefore into transportation facilities) varies widely by regions and (c) the levels to which regions believe it economically feasible to carry their planning varies widely. (In a sense these last two things are the same.)

Effect of Use of Aircraft on Trail System

Increasing use of aircraft in fire control over the last decade, and particularly smoke jumper attack, has changed the requirements for a protection trail system but not nearly as much as is generally supposed. On 10 forests in north Idaho and northwest Montana having a high fire potential and a trail system with about a mile of trail per square mile of area, it is almost certain that important reductions in the total trail mileage can be made. These reductions will equally certainly be made chiefly in the low standard "way" trail system, having little use in the past except by an occasional smoke chaser and the crews that maintained them. With this major exception, the possibility for reductions elsewhere appears to be limited as far as fire control is concerned. Even if all ground organization were supplanted by smoke jumpers, a trail net of some intensity would still be required to get jumpers and their gear back to base. In rough, timbered terrain about 1½ miles is reported to be the maximum distance jumpers can be expected to pack their gear across country. Assuming that as a maximum that can be tolerated would still require a system varying in intensity between 0.6 and 1.0 mile of trail per square mile of area, depending on topography and the road system.

At the risk of appearing reactionary or lacking in vision, we believe there is nothing at present to warrant reducing the trail system because of possibilities in the helicopter of other unconventional types of aircraft. In time the price, freight capacity, ratio of weight to horsepower, performance at intermediate altitudes, etc., of such craft, may revolutionize fire control practice and trail requirements. When this becomes fact, appropriate action can be taken to revise the trail system.

Road and Trail Intensity in Combination

The difficulty with each of the preceding indicators is that, while they all point the same way, quantitatively they are too indefinite.

It is quite possible that if we had enough blocks of, say 25,000 acres, each representing a distinct level of

fuel type
fire occurence
topography
climate (possibly)
concentration of surrounding population

and in addition the road-trail intensity in each was as it should be, (in short, a controled experiment on a massive scale) an equation could be set up that would answer the question of what is required in any sort of combination of these variables. As has already been pointed out, it would be impossible to find a single such area as regards the first three variables. Further, even assuming that such a solution were possible, it would be a monumental task to apply the findings to the rest of the country and the cost probably would greatly exceed any possible benefit.

At the same time a transportation planning methodology such as has been applied to roads does not appear feasible, since

(a) its very essence is economic justification and a large part of the trail system is used lightly, primarily for fire and that kind of a yardstick simply does not work;

(b) a more or less geometrical pattern of trails providing access to all areas is necessary for general administrative purposes including the return of smoke jumpers where that form of protection is used;

(c) actual and expected use of trails is hardly more than a wild guess at present - therefore, any very rigid application of economics falls flat;

(d) planning procedures in themselves do not produce uniform or comparable results. The characteristics and tendencies of the people who apply them have at least as much effect.

For these reasons we recommend against any elaborate or time consuming procedure for trail transportation planning. At the same time there seems to be a need for better guides than we now have - a general floor and ceiling for trails in terms of the existing and proposed road or other transportation system. The details of such a guide and the end result follows:

Some preliminary experimenting in 1946 with combined road-trail intensities by regions looked promising. Subsequent analysis disclosed a well defined pattern of combined intensities by climate types

in the western regions. These are broadly generalized and each represents a fairly distinct level of fire load. Plate 1 shows the six western groups of forests finally decided upon for this method of analysis. It has been the aim to have these groups include parts of two or more regions, if cover, fire occurrence, seasonal, or other characteristics were generally the same. Some forests fit nearly equally well in the group to which assigned or in the nearest adjoining group, and such shifts can be and were made in several instances without changing the curve characteristics except slightly.

Group 1 (see top half of plate 2) which includes about 63,000 miles of trail could be broken into two or more groups on regional or other lines without changing the curve characteristics to any great extent. The raw data for the Coeur d'Alene, Kaniksu, St. Joe, Mt. Baker, and Olympic Forests fall wide of the curve because of ownership pattern and protection areas inside and outside the boundary and due to large areas of barren (Mt. Baker).

Groups 3, 4, and 5 (plates 3 and 4) could be consolidated without much deviation from a mean curve for any one of the three individual curves. The Carson, Santa Fe, and Black Hills Forests deviate widely from the group patterns for reasons unknown to us.

Plates 2, 3, and 4 show the existing system.

Forests were selected as "guinea pigs" in each group to see what revisions could be made in the existing and proposed trail system by the conference method. The forests were:

Group 1 - Angeles R5, Klamath R5, St. Joe R1, Willamette R6
Group 2 - Bitterroot R1, Fremont R6
Group 3 - Teton R4, Uinta R4
Group 4 - Routt R2, San Juan R2
Group 5 - Cibola R2, Gila R2

We took part in the first conference in each region. Generally rangers, forest engineer, supervisor or assistant and one to several regional office divisions were present at least part time. Subsequently, each western region held a conference for a second forest, which fell at the opposite end of the curve (see plates 2-4) than the first one.

These conferences were round-table discussions of every individual project, its purpose, the amount of use it gets, the physical characteristics of the area served, etc. The result is a forest-regional product -- not ours, although we took the position of questioning observers and made it clear a system that fulfilled minimum requirements was the objective. Cooperation was good, although there were individuals who balked at doing anything despite

the fact they were completely out of line with their neighbors.

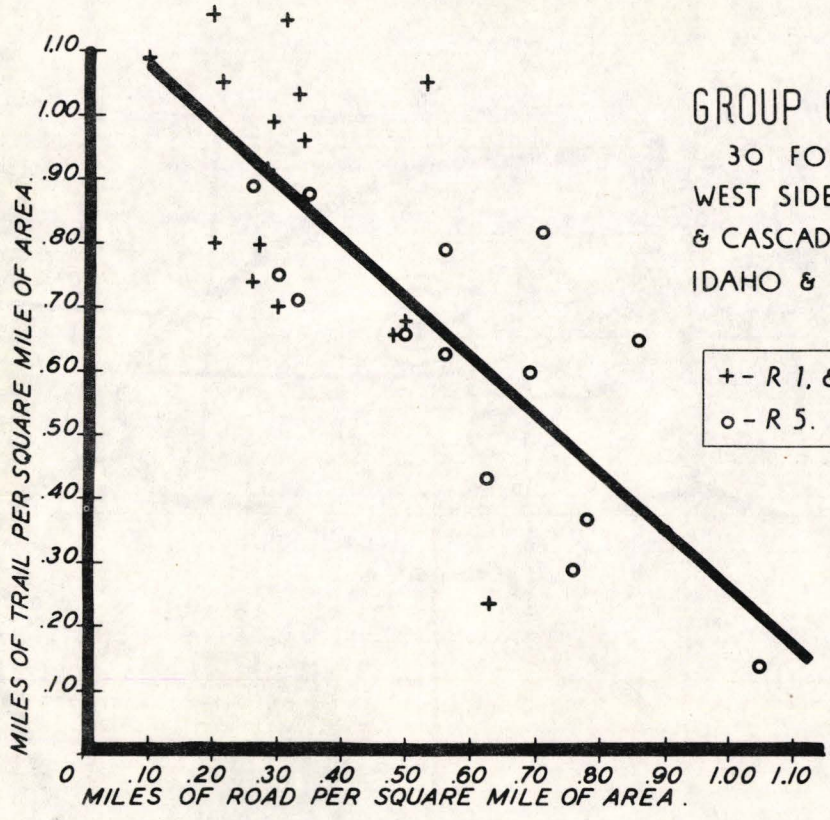
Nothing was knocked out of the system if there was much question that it should not be. The number of such projects or mileage varied considerably from one forest to another. We necessarily formed some conclusions about what part, if any, of the remaining system could be dropped without anybody being hurt. It is to be kept in mind that the people on the ground themselves questioned a lot of mileage that at the end of the conferences was left in the system, so our estimate of how much more could be dropped is not an umpire's decision.

The results of the conferences and our estimate of what further could be done, are shown in the following table:

	Existing system - miles per square mile			
	Mar. 1, 1946		Conference result	Ceiling Recommendation
Group and Forest	Roads	Trails	Trails	Trails
1. Clearwater	.20	1.16	.96	.89
Cabinet	.31	1.15	.88	.77
Colville	.48	.66	.55	.60
Klamath°	.35	.88	.65	.73
Rogue River	.50	.68	.54	.58
Willamette	.21	1.05	.96	.88
°adjusted to Six Rivers elimination				
2. Bitterroot	.10	.96	.84	.86
Lolo	.20	.80	.71	.75
Nez Perce	.33	1.07	.89	.59
Fremont	.74	.10	.08	.11
3, 4 and 5.				
Montezuma°°	.39	.48	.43	.35
Routt	.20	.42	.36	.50
San Juan	.20	.59	.51	.50
Harney°°°	.76	.01	.01	.07
Cibola	.70	.24	.21	.12
Gila	.38	.51	.44	.36
Sitgreaves°°°	.95	.00	.00	0
Bridger	.14	.82	.76	.54
Teton	.10	.48	.49	.57
Uinta	.29	.69	.58	.43
°°allows for recent area adjustment.				
°°°no conference - only data available for forests with heavy road intensity and relatively no trails.				
6. No forest conferences on desert group.				

INDEX TO WESTERN FOREST GROUPS.

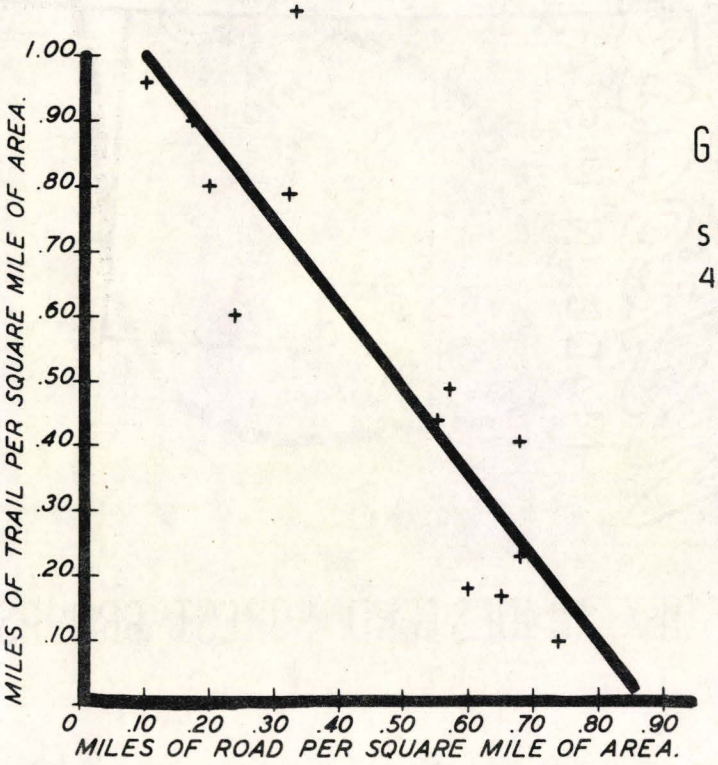
PLATE 1.



GROUP ONE.

30 FORESTS---
WEST SIDE SIERRA NEVADA & CASCADE RANGES & NORTH IDAHO & WASHINGTON.

+ - R 1, & R 6.
o - R 5.

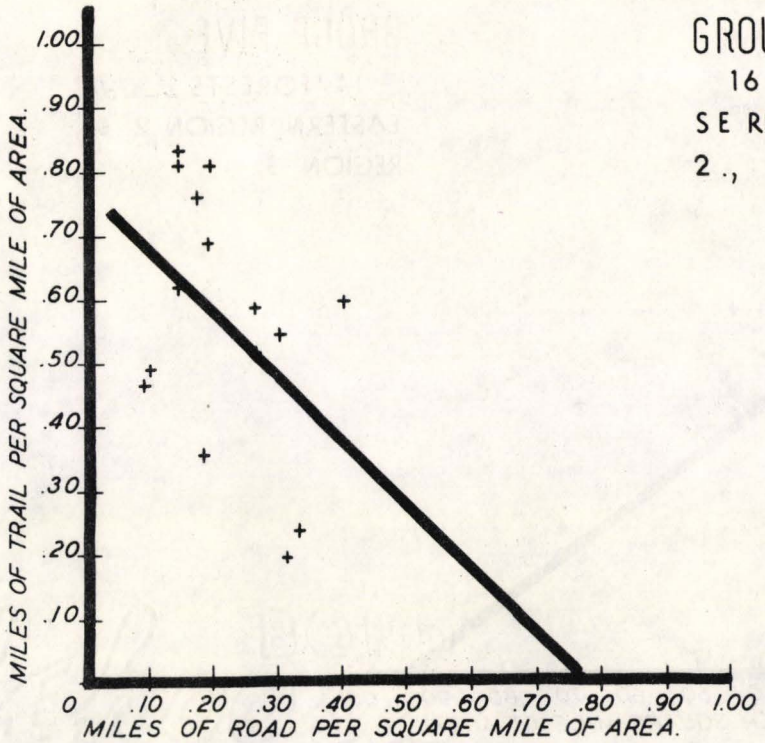


GROUP TWO.

13 FORESTS---
SW REGION 1., NW REGION 4., SE REGION 6.

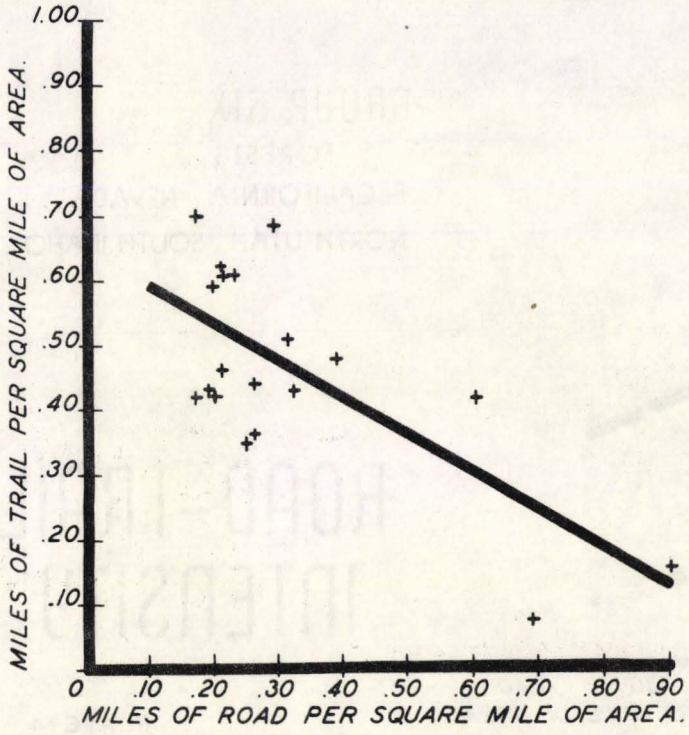
ROAD-TRAIL INTENSITY

PLATE 2.



GROUP THREE.

16 FORESTS---
SE REGION 1., NW REGION 2., NE REGION 4.

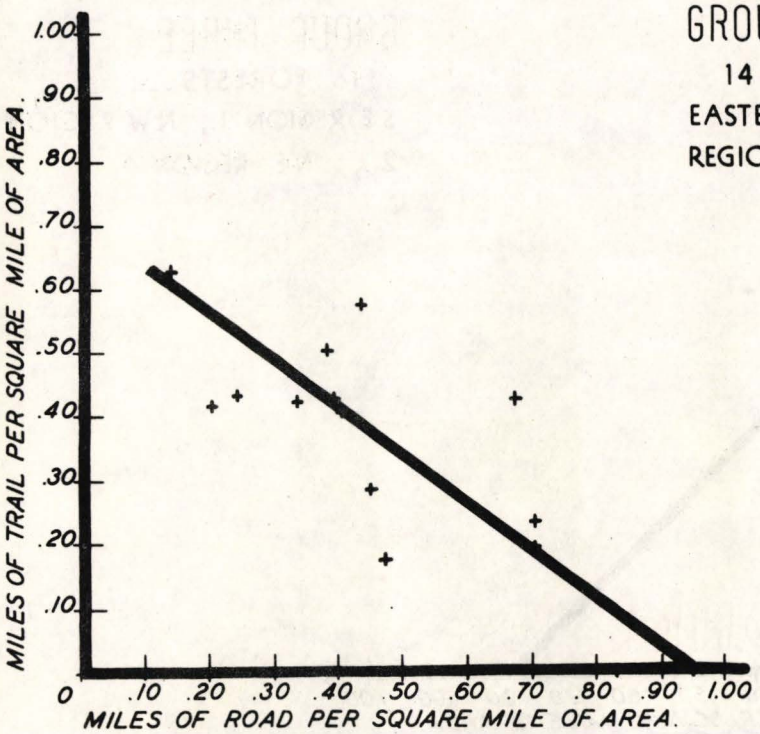


GROUP FOUR.

19 FORESTS---
WESTERN REGION 2 & 3., SOUTHEAST REGION 4.

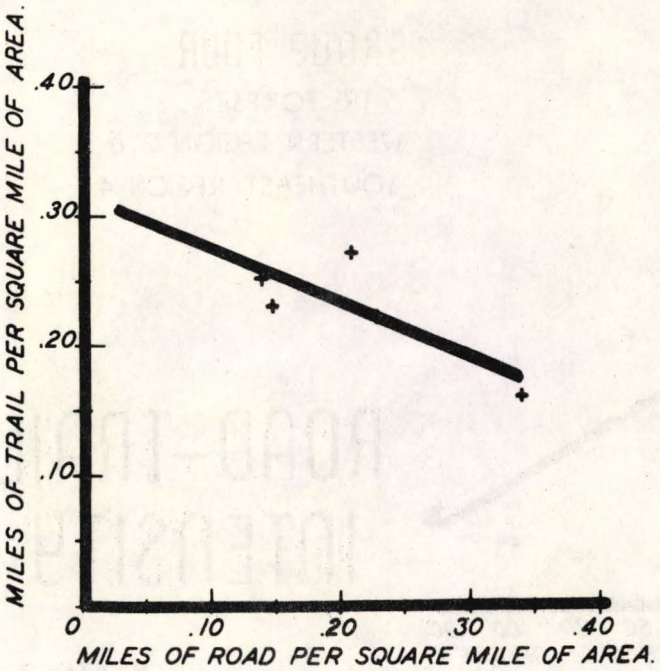
ROAD-TRAIL INTENSITY

PLATE 3.



GROUP FIVE.

14 FORESTS ___
EASTERN REGION 2 & REGION 3.

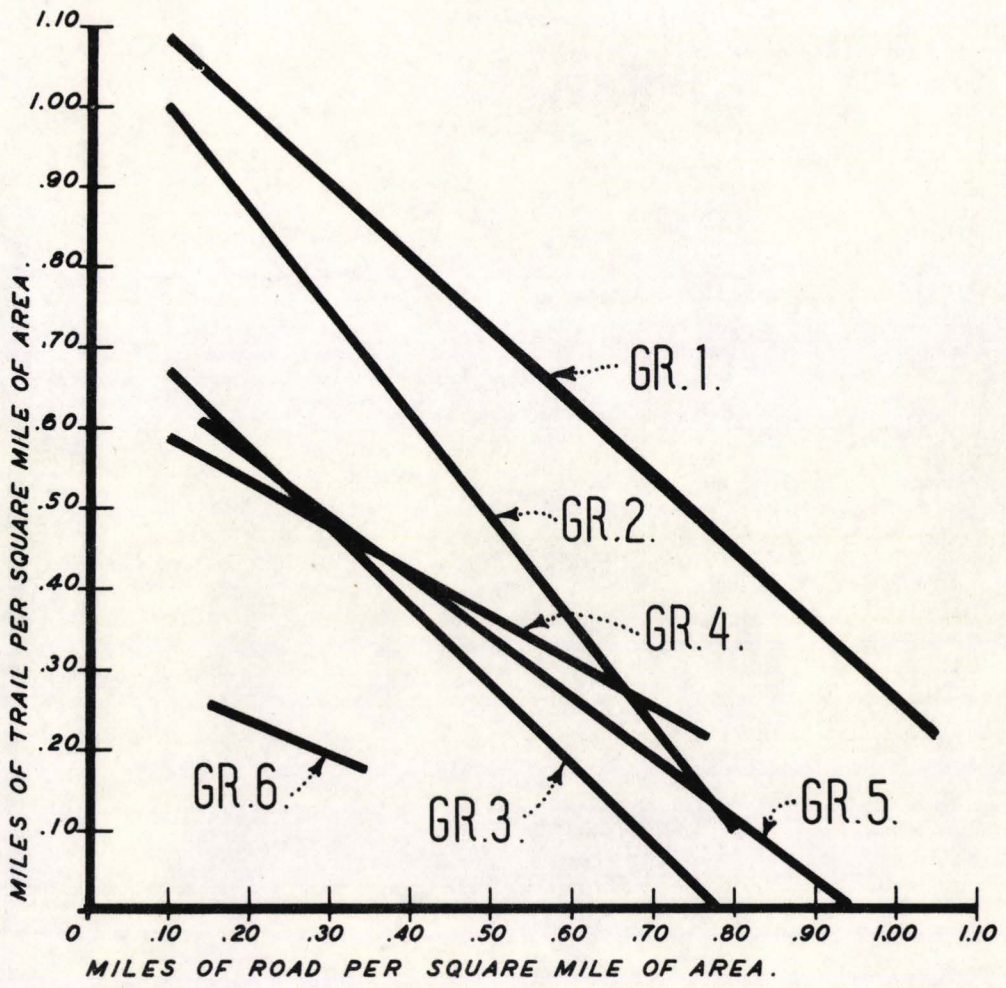


GROUP SIX.

5 FORESTS ___
E. CALIFORNIA, NEVADA, NORTH UTAH, SOUTH IDAHO.

ROAD-TRAIL INTENSITY

PLATE 4.



ROAD-TRAIL INTENSITY

COMPOSITE OF SIX WESTERN GROUPS
EXISTING SYSTEM ONLY.

PLATE 5

The effect of the preceding table on the intensity of the existing system is more readily grasped by inspection of Plates 2a, 3a and 4a. Our recommendations go somewhat beyond the results of forest conferences, not because they can be disregarded, but on the ground that, almost without exception, most questionable projects remained in the system after the conferences. We are confident that many such projects could safely be eliminated. The solid red lines on Plates 2a, 3a and 4a indicate, by comparison with the broken red lines, how much beyond the forest conference result we believe it is reasonable to go. The black trend line provides a comparison with the existing system as of March, 1946, when this project was started.

The following table is a summarization for all regions, based on the solid red curves (or more exactly on the equation in red shown on each):

Summary of Recommendations

Region	Recommended Existing Mileage	Reported Existing Mileage March 1, 1946	Recommended Reduction	Percentage Reduction
1	27,515	37,152	9,637	25.94
2	14,935	15,997	1,062	6.64
3	7,041	12,391	5,350	43.18
4	23,849	26,957	3,108	11.53
5	17,741	20,299	2,558	12.60
6	24,944	26,350	1,406	5.33
7	3,546	4,205	659	15.67
8	2,548	2,925	377	12.89
9	479	948	469	49.47
10	1,058	1,058	0	0
Tropical	50	50	0	0
Total or Average	123,706	148,332	24,626	16.60

In the western regions a comparison of road-trail intensity for the recommended system is interesting.

Intensity of Recommended System
(Western Regions only)

Region	Miles trail per sq. mi.°	Miles of road per sq. mi.° (Progress Record)	Miles of road and trail per sq. mi.
1	0.63	0.28	0.91
2	0.44	0.29	0.73
3	0.20	0.58	0.78
4	0.47	0.20	0.67
5	0.48	0.53	1.01
6	0.59	0.42	1.01

°Gross area

Anyone interested in seeing how the Regional totals were arrived at (in the next to last preceding table) can do so by applying the equations shown on Plates 2a, 3a and 4a to individual forests by the groups shown on Appendix pages 30-32, using the road intensity shown opposite each.

The forests that differ widely from the normal curve are worth mentioning. Those with trail mileage out of line above the normal are:

Region 1	Region 2	Region 3	Region 4
Cabinet°	White River	Prescott	Bridger
Coeur d'Alene	Montezuma°	Crook	Salmon
St. Joe		Coronado	Sawtooth
Kaniksu		Gila°	Uinta°
Nez Perce		Cibola	
Helena		Lincoln	
Gallatin		Santa Fe	
		Carson	

Region 5	Region 6	Region 7	Region 8
Angeles	Mt. Hood	Geo. Washington	Cherokee
Stanislaus	Columbia	Monongahela	
Eldorado	Malheur	White Mtn.	
Tahoe	Umatilla	Alleghany	
Mendocino			

Those with trail mileage out of line below the normal are:

Region 1	Region 2	Region 3	Region 4
Deerlodge°	Pike	Kaibab	Dixie
Beaverhead°			
Custer			

Region 5	Region 6	Region 7	Region 8
Modoc	Siuslaw	Jefferson	Chattahoochee
	Mt. Baker	Green Mtn.	Nantahala
	Olympia		
	Deschutes		

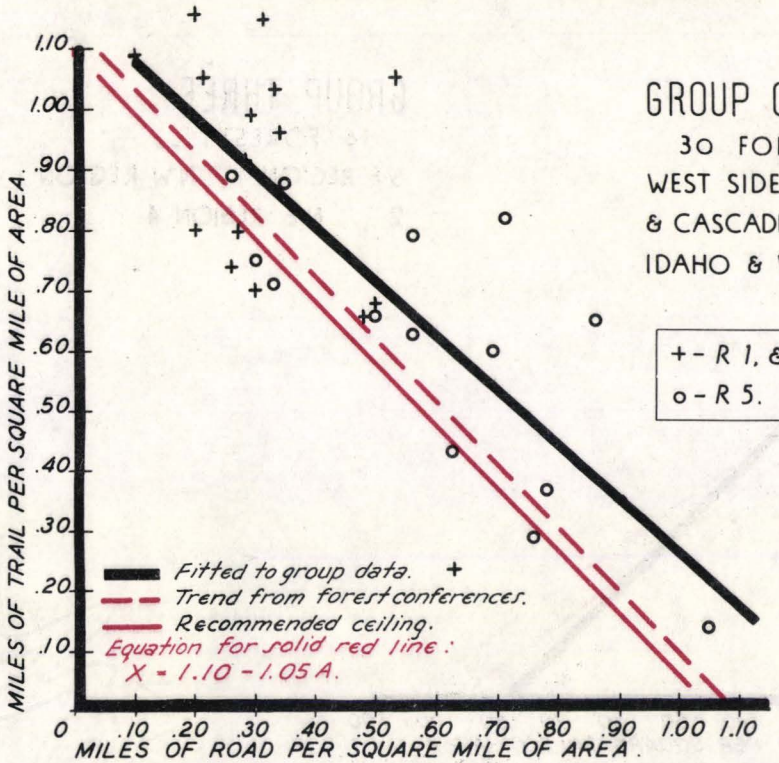
°Brought into line after forest conferences.

Some of these deviations are readily accounted for. For example, land ownership pattern as it affects the size of protection areas probably accounts for the excess on the Kaniksu, Coeur d'Alene and St. Joe. Either gentle or abnormally rough topography accounts for other deviations such as the Custer, Kaibab and Modoc on the one hand and the Salmon, Stanislaus and Mt. Hood on the other. There simply is no rational accounting for some of the others.

The non-existing (proposed) system

Indications are that non-existing (proposed new) trail mileage need not exceed about 3% in any region and for all regions may be well under 2% of the existing system.

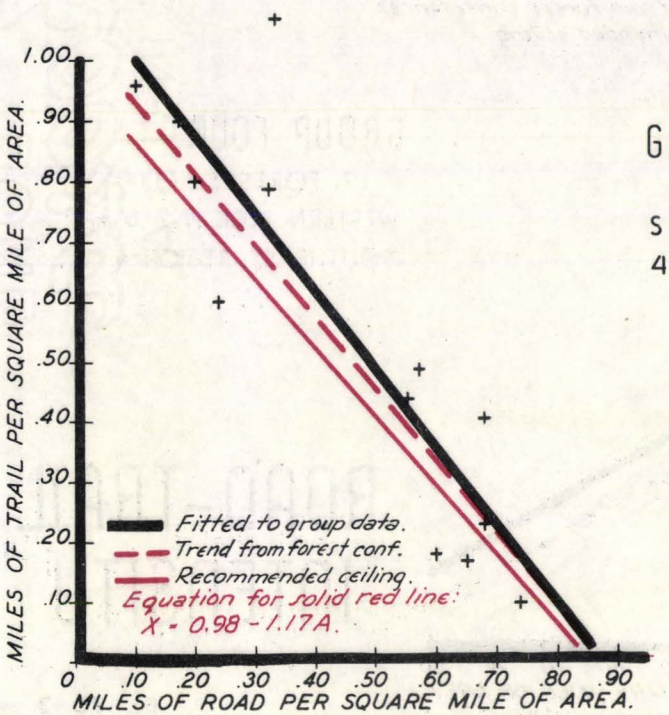
This report has dealt almost exclusively with the existing system, first because it will surely be increased only slightly by future additions; second, it is possible or even probable that the current existing mileage will in the aggregate never need to be increased at all because the construction of roads will tend to eliminate existing trails or the need for proposed trails as fast as or faster than the need for new trails will develop; third, there should be a rigid embargo on new trail construction until deferred maintenance and urgent betterment on the existing system has been done.



GROUP ONE.

30 FORESTS---
WEST SIDE SIERRA NEVADA & CASCADE RANGES & NORTH IDAHO & WASHINGTON.

+ - R 1, & R 6.
o - R 5.

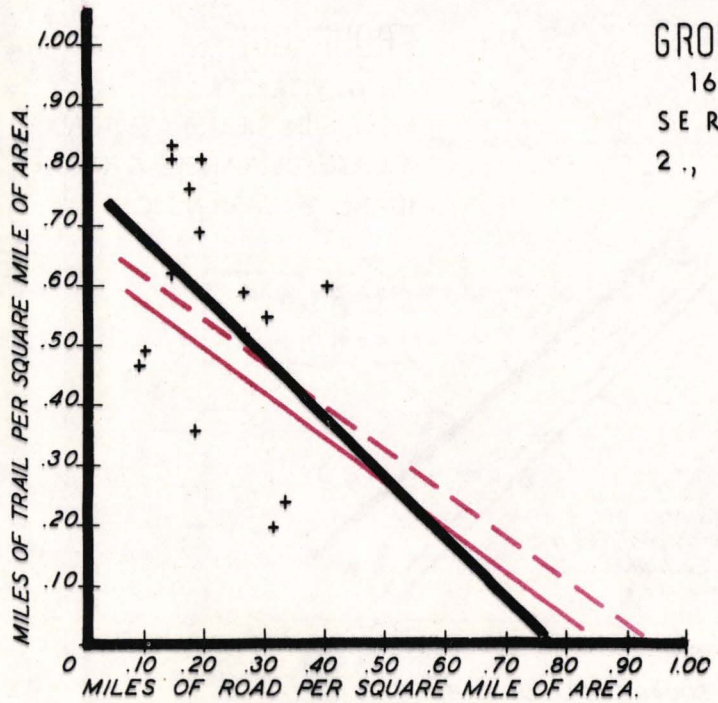


GROUP TWO.

13 FORESTS---
S W REGION 1., NW REGION 4., S E REGION 6.

ROAD - TRAIL INTENSITY

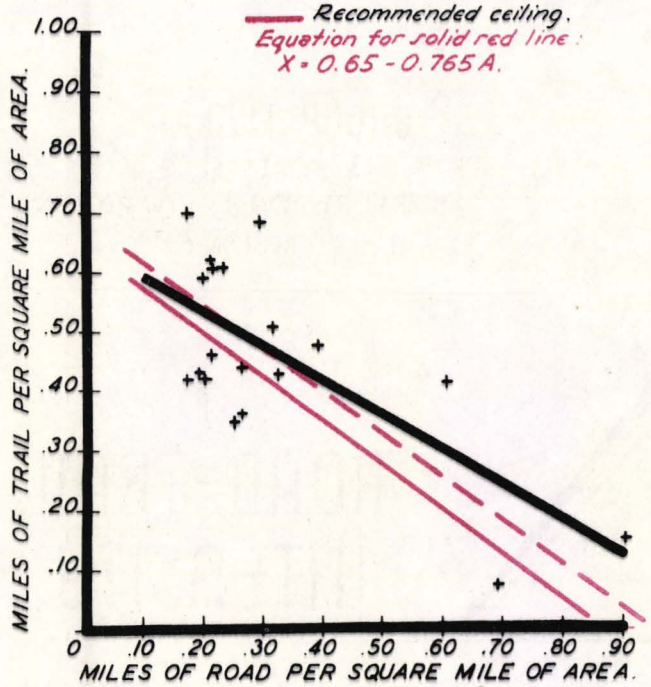
PLATE 2.



GROUP THREE.

16 FORESTS---
SE REGION 1., NW REGION 2., NE REGION 4.

Fitted to group data.
Trend from forest conferences.
Recommended ceiling.
Equation for solid red line:
$X = 0.65 - 0.765A.$

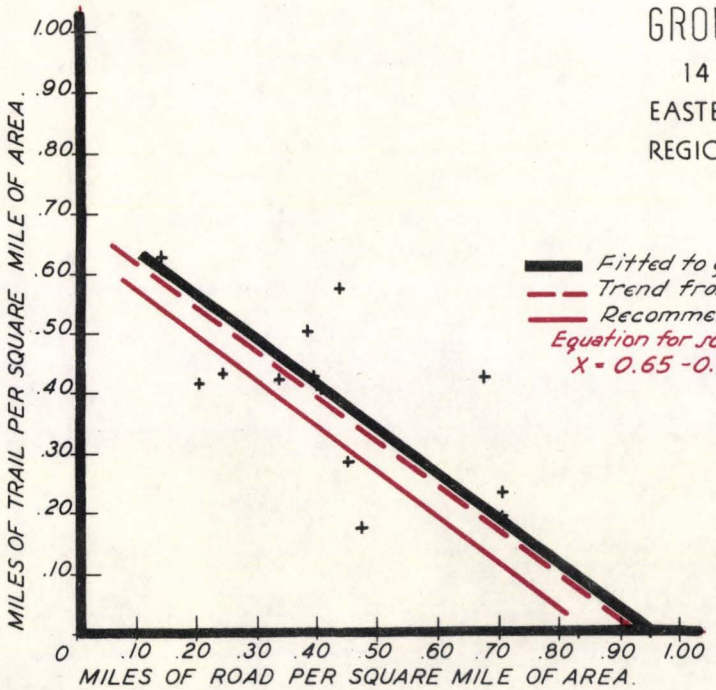


GROUP FOUR.

19 FORESTS---
WESTERN REGION 2 & 3.,
SOUTHEAST REGION 4.

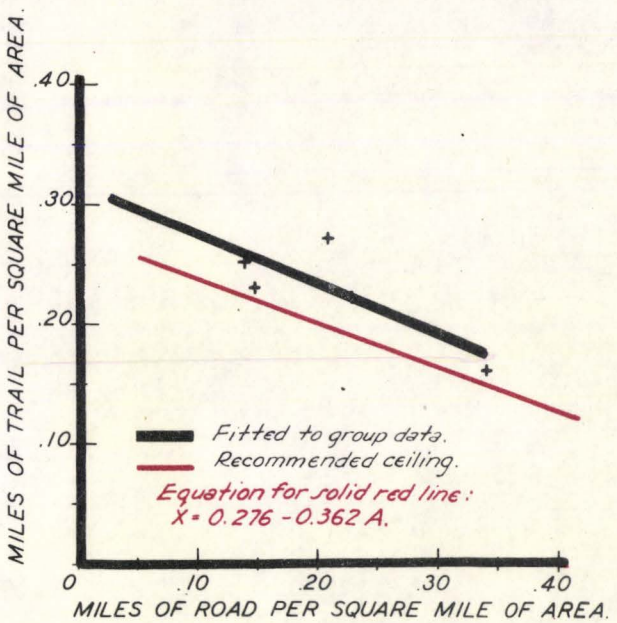
ROAD-TRAIL INTENSITY

PLATE 3.



GROUP FIVE.

14 FORESTS ___
EASTERN REGION 2 &
REGION 3.



GROUP SIX.

5 FORESTS ___
E. CALIFORNIA, NEVADA,
NORTH UTAH, SOUTH IDAHO.

ROAD-TRAIL INTENSITY

PLATE 4.

Some Observations about Regions 7, 8 and 9.

The same curve is used for Regions 7 and 8 forests as was used for Groups 3, 4 and 5 in the west, except that it is applied against areas under F.S. administration rather than gross areas. The recommendations are applied to all forests in Region 7 except the Cumberland, but only to the Cherokee, Chattahoochee, Nantahala and Pisgah in Region 8. There is no need for trails in the Coast and Piedmont forests including Arkansas, except nominal mileage in short spurs to reach lookout towers. For Region 9, with only the Superior having any mileage of consequence, we accept the mileage figure of 479 resulting from a recent revision by the Region, although it is less than half the mileage indicated by the curve for Groups 3, 4 and 5. This is doubtless due to the many lakes which serve as connections between short sections of trail.

Trails in Regions 7 and 8 are relatively unimportant as compared to roads. The county is better roaded than in the west and with minor exceptions they are used for fire purposes rather than trails. It is easier and faster to use Forest Service, county and old logging roads into the base of a mountain and climb to a fire than to drive into a mountain saddle and walk several miles out a trail. In most instances in Regions 7 and 8 fires occur along the base of the mountains, usually escaping from fields or new ground operations where brush is being burned. Most fields are accessible by truck and the result is that few trail miles are used in fire suppression work. Occasional areas require trails for access but for the most part roads answer the needs better. Once these Regions have fully exploited their timber management possibilities, the ~~administ~~rative need for trails will have practically disappeared.

One exception to this is the White Mtn. N.F. in R-7. In parts of it cross country travel is practically impossible due to hurricane damage. Trees are piled up in such confusion in some areas that travel time is reduced to 1/4 to 1/2 mile per hour.

The recreational traffic is low on most trails excepting those in the White Mtn. N.F. This held true for the much-talked-of Appalachian Trail. Except for short sections near roads or recreational developments, it has remarkably little use. Through traffic is negligible. In some instances there was no known use of the trail by through traffic.

Regions 7 and 8 trails have reasonably heavy hunter use in the fall and in many places trails greatly help to obtain proper distribution of hunters. In localities with a heavy brush cover and large deer concentrations, it would be almost impossible to get the required kill without trails. This is especially true of wildlife management areas. For the present there appears to be no need for additional miles of trail in this category.

We were not impressed by either present or prospective use of trails in either Region 7 or 8, but in view of the concentration of surrounding population, game management problems and fire protection, we can recommend, as already pointed out, the same trail intensity as for Groups 3, 4 and 5 in the west for areas under F.S. administration.

In Region 9 on the Superior, the need for trails is or shortly will be limited to the wilderness area with use chiefly by recreationists and for fire secondarily. The portage system is interesting, unique, and reported to be extremely heavily used. Trail need in terms of area and

road mileage is hardly applicable, as about half of the forest is so well roaded as to require no trails and the other half (with some roads) has a non-continuous trail system composed of short sections connected with comparatively large or long bodies of water. The progress record figure of 886 miles existing and 237 non-existing is unquestionably more than is needed.

The Region's estimate of 479 miles existing and 47 miles non-existing is certainly nearer the mark and a better estimate than we can make.

Region 10 and Tropical Forestry

No field examinations were made in Region 10 or Tropical Forestry because more time and expense would have been required than the size of the job appeared to justify. Consequently, we are accepting the existing and proposed trail mileage as being proper. We can hardly be expected to make a reliable estimate of maintenance cost for something we have never seen but venture the guess that in Region 10 it may be twice the average cost for the coast forests in the State of Washington, due to wage levels, excessive transportation costs, etc. At this rate, the estimate would be $24 per mile per year.

For Tropical Forestry we guess twice as much, or say $50 per mile, for annual maintenance for foot trails and twice that for bull cart trails or say $75 per mile average. In any case the mileage (50) is so small the effect on the over-all estimate is negligible.

Effect of road construction on trail system

The trail system should be slowly reduced as construction of the proposed road system proceeds. Disregarding the glaring relative inconsistencies in the planned road system as between regions and using values from the curves of Plates 2a, 3a and 4a, the mileage of trail can be calculated when the planned road system is completed. This is beyond the scope of this assignment and is not included in detail. Tentatively, the ultimate trail system, conforming to the planned road system, is indicated to be about 80,000 miles or about 2/3 of the mileage recommended for the present.

Summary and Conclusions

1. We recommend an existing system with annual maintenance and deferred maintenance - betterment estimate all in terms of the 1947 dollar as follows:

Region	Recommendations			
	Existing Mileage	Annual Mtce. (per mi.)	Annual Allotment	Urgent def. mtce. betterment needed
1	27,515	9.96	274,049	207,738
2	14,935	5.51	82,292	374,719
3	7,041	5.54	39,007	155,888
4	23,849	7.06	168,324	546,381
5	17,741	10.25	181,845	496,393
6	24,944	11.04	275,382	485,410
7	3,546	5.16	18,297	16,808
8	2,548	4.75	12,103	12,077
9	479	9.93	4,756	-
10	1,058	24.00	25,392	-
Tropical	50	50.00	2,500	-
Totals or Average	123,706	8.77	1,083,947	2,295,415

The recommended reduction of 24,626 miles in the system represents a potential annual saving of $205,000 or that amount available for higher priority work. We prefer to think of it as the latter. An additional "saving" of approximately half that amount can be made if the method for estimating trail mileage outlined in Appendix pages 32-35 is followed.

2. We see little chance of the regions getting on top of the maintenance job unless a substantial part of the deferred maintenance-betterment estimate becomes available in the near future.

3. With the current trend in the cost of living, these estimates will probably have to be revised upward not later than for field season 1949. The report and supplement provide all the necessary guides to do this since the original field estimates are in time rather than dollars.

4. Numerous practices and habits will have to be mended before any reasonable estimate will be adequate to do the job. The more important of these appear to be:

(a) Cultivation of a positive, militant attitude about getting the job done,

(b) Doing the utmost to provide wage and working conditions making it possible to compete with outside employment,

(c) Better selection of trail workers,

(d) Insistence on simple, written work plans,

(e) Training that insures that workers know what is expected of them,

(f) Use of the most effective methods - we doubt that the small tractor is the answer for more than 10-15% of the trail system; there are large possibilities in a mechanical brush-cutting device, in power saws in insect-killed timber in the interior west and in horse-plow grading outfits everywhere,

(g) Funds should be allotted so as to give the man on the ground maximum participation in financial planning and as much advance notice of

funds as possible. Funds should scrupulously be spent only for the purpose for which allotted,

(h) Some changes in existing standards appear to be in order and these presumably will be made via handbook revisions,

(i) Development of the competitive spirit through matching performance of crews and contracting maintenance should be more widely practiced,

(j) Supervision is almost completely lacking at all levels; somebody is going to have to insist more forcefully on a reasonable amount of production,

(k) This job is big enough and will remain so for a long time, to justify improving the quantity and quality of inspection at all levels.

This report should not be concluded without remarking first, that we doubtless drew poor samples in some places and may have been unduly influenced by them; second, we have to assume that the over-all sampling was good or at least adequate; third, that the generalization to the effect that "the current state of maintenance of the trail system is bad everywhere" made on page 3, may be too sweeping. It is worth repeating that on no single forest anywhere did we find a good or even acceptable job. The Klamath in Region 5 and the Siskiyou in Region 6 came nearer qualifying as whole units than any others we saw. To mention some of the better quality jobs, we found relatively outstanding work being done on the following ranger districts:

Spotted Bear - Flathead
Powell - Lolo
Lochsa - Clearwater
Alamosa - Rio Grande
Taos - Carson
Frisco - Mogollon - Gila
Lake Fork - Payette
Santa Maria - Los Padres
White River - Snoqualmie
Bear Sleds - Wallowa
Tallulah - Chattahoochee
Deerfield - George Washington

Probably no one of these rangers considers adequate the job that is being done. The better than average maintenance jobs are impressive, wherever found, because they accentuate the poor jobs sometimes found alongside them. They indicate that the energy and will to get the job done may after all be the most important factor in this situation.

Lastly, this is an opportunity to express our appreciation for the kindly consideration and helpful cooperation accorded us nearly everywhere. At all levels of organization, people went "all out" in arranging trips, supplying data and doing all the things necessary to the job. This made bearable a job that was often tiresome with plain drudgery.

H M Shaw
Civil Engineer

E R De Silvia
Forester

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United States Department of Agriculture
Forest Service

E
ROADS & TRAILS
General
(Trail Studies)

Washington 25, D.C.
March 27, 1946

Circular E-3150

Regional Forester
All Regions (Except Region 10)

Dear Sir:

We are spending nearly a million dollars per year maintaining the Forest Trail System, with a rather common feeling that the results are not commensurate and often not adequate. No comprehensive study or examination of the system has ever been made. With current and impending developments in aircraft and other forms of mechanization, this seems to be an appropriate time to take stock. You have already been advised that such a study will be made (see "E ROADS & TRAILS General" letter of February 15). It will be confined to Regions 1, 3 and 5 in 1946. This is merely informational for other Regions for the present.

The primary purpose of the study is to examine critically the existing system to find out whether, in the light of present and prospective transportation facilities, it is what we need; if not, to develop examples or indicators of what is needed; secondarily to find out what the existing system is costing to maintain and whether the level of maintenance is adequate and reasonable in cost.

The study necessarily must be conducted on a "spot" basis. It, therefore, can hardly be expected to develop the ultimate answers. It is expected to point the way toward them with reasonable certainty. The Regions will still have a job to do in detailed replanning as a follow-up to the study.

The job is divided into three phases:

1. Advisable eliminations from the system, present and future
   Mileage replaced or likely to be replaced by roads. Effect of constructing landing strips or helicopter spots; effect of use of jumpers on fires; little-used ways; utility of ungraded blazed ways, miners' trails and old fire camp trails absorbed into the system; need for driveways vs. hauling of livestock; actual use of trails built exclusively for fire; etc.

2. Additions to the system, Standards and Cost
   Are Progress Record and P.W.I. figures realistic? Betterment of trunk

trails versus or prior to extensive additions; justification for the one-purpose trail; opening up new forage areas; relocation of stock driveways away from roads and recreation areas; integrated systems for recreation; effect of changed and changing hour control objectives.

3. The existing system; a condition and maintenance cost survey. Standards; current unit cost; what it should cost; organization and its relation to other activities; maintenance plans; possibilities and effects of mechanizing; on standards, costs, etc., accuracy of reported mileage in system; cost-benefit ratio and any other points that are found to bear on the matter. This survey should supply some basic data for 1 and 2.

With about 146,000 miles in the existing system, it is obvious that a sampling procedure must be used. The forests in each Region have been divided into several groups having generally similar characteristics as regards this problem. One forest has been selected at random from each group. This grouping and selection has been discussed with Regional Engineers at their recent meeting but has been extended somewhat to insure adequate sampling. From the maps mentioned below, further sampling will be done to select the areas on which individual trail projects will be examined, getting the data already referred to. The sampling procedure was worked out in Forest Economics.

The following data will be needed to be prepared in the field for <u>all</u> forests in Regions 1, 3 and 5 at least a week prior to any field examinations:

1. Show on a 1/4" forest map the existing forest trail system by the following colors in pencil lining over the trail symbol;
   (a) Trunk trails and special trails -- Green
   (b) Driveways -- Brown
   (c) Connecting trails -- if the trail symbol is left uncolored it will be assumed to be a connecting trail. See Trail Handbook for definitions.
   (d) Show in the legend of the map the mileage in each of the three preceding trail classifications. Total should equal figure reported in the Progress Record.
   (e) On a separate map, break up forest into sub-units not smaller than 1/2 township in size and not more than 1-1/2 townships in size. Boundaries of such units should be on natural objects such as a topographic divide, road, creek or the like. Classify each of these sub-units as to difficulty of maintaining the trail system as follows:

      Easy -- Yellow -- Solid Color -- lightly
      Difficult -- Red -- Solid Color -- lightly

(This is a utility map and requires no refinements in drafting). The dependability of the results of one phase of this study will rest largely on the detailed accuracy of this classification. It, therefore, should be made by the person who is most intimately familiar with conditions. In making the classification, some thought should be given to at least the following things which affect maintenance:

Type, amount and condition of cover
Soils, including amount of rock
Topographic relief
Number and complexity of structures

(f) It would be helpful if, for the forests listed in the schedule, local officers have made notes in advance on the existing system as to its adequacy or whether it is overdone and in what respect.

Schedule

R-5	April 25 - May 10 Sept. 23 - Nov. 1	Los Padres Klamath, Sierra, Plumas, Shasta, Trinity
R-3	May 13 - June 7	Crook, Tonto, Gila, Cibola, Carson
R-1	June 20 - Sept. 14	Coeur d'Alene, Nezperce, Lolo, Flathead, Lewis & Clark, St. Joe, Deerlodge, Beaverhead, Colville

Shank and DeSilvia will work together in the same general territory, but separately on different areas about 80% of the time. Trip plans should be prepared only after their arrival in the Region, except that the general plan will be to spend about a week per forest in whatever order seems best to Regional officers. The selection of forests is not inflexible, but will not be extensively changed for the present. However, later on in the course of study, methods may have to be modified or sizes of samples varied.

Regions will be expected to furnish two vehicles for transportation and to arrange and finance subsistence supplies, packstock, etc., for cross-country trips.

Very truly yours,

LYLE F. WATTS, Chief

By C. M. Granger

NATIONAL TRAIL STUDY

Name of Trail_____ Date _____

	Spaces to be filled in	Sample Mile # 1	2	3	4	5	6	7	8
1 Region	1								
2 Forest	2								
3 District	1								
4 Type Trail	1								
5 Months Use Ann.	2								
6 Major Purp. Trav.	1								
7 Traffic Vol.	3								
8 Freight Vol.	3								
9 Soil	1								
10 Av. Hillside Slope	1								
11 Annual Rainfall	1								
12 Type of Cover	2								
13 Cond. of Cover	1								
14 Trees per Sta.	1								
15 Av. D.B.H.	1								
16 Airline Miles to nearest road	1								
17 Airline Miles to nearest trail	1								
18 Lin. ft. Str. Bridge	3								
19 Lin. ft. Susp. or Truss Bridge	3								
20 Actual Freq. Clearing	1								
21 Required " "	1								
22 Actual " Grading	1								
23 Required " "	1								
24 Ex.Est.M.H.Mtce.Req.per Yr.	1								
25 Rangers M.H. " " " "	1								
26 Man hours in Last Mtce.	1								
27 Trail Maint. this year	1								
28 Area grazed by livestock	1								
29 Condition of Signing	1								
30 Location of Trail	1								
31 Est. of Const. Cost in Man Days per Mile	3								
32 Est. of Betterment Cost in Man Days per Mile	3								
33 Miles Relocation Repl. Needed	2								
34 Classification of travel	1								
35 Easy - Difficult Area	1								

CODE SHEET FOR NATIONAL TRAIL STUDY TALLY SHEET

Line No. On Tally Sheet	Sample Item	Punch Card Col. No.	Code as Indicated
1	Region	Col. 1	Code in numerical order.
2	Forest	Col. 2 & 3 (See Supplement)	Code in alphabetical order by Regions.
3	District	Col. 4	Code - Actual
4	Type Trail	Col. 5	Graded - 1 Ungraded - 2
5	Months Use An.	Col. 6-7	Actual Months 01 = 1 etc. 12 = 12
6	Major Purp. Tr.	Col. 8	Code: Fire -- 1 Gen'l Adm. -- 2 R.M. -- 3 Rec. -- 4 Other -- 5
7	Traffic Vol.	Col. 9-10-11	Code -- Actual No. persons, or animals per mo. x = unknown
8	Freight Vol.	Col. 12-13-14	Code -- Actual tons & tenths of tons per mo. x = unknown (i.e. 012 = 1 and 2/10 tons) 01.2
9	Soil	Col. 15	Code -- Highly Erodable -- 1 Average Erodable -- 2 Stable -- 3 Heavy Rock Constr. -- 4 Average " " -- 5 Light " " -- 6
10	Av. Hillside Slope	Col. 16	Code -- 0-10% = 1 51-60% = 6 11-20 = 2 61-70 = 7 21-30 = 3 71-80 = 8 31-40 = 4 81-90 = 9 41-50 = 5 91-100 = 0
11	Max. Rainfall in 24 Hours (Inches)	Col. 17	Code -- Actual inches up to 10 inches - 10+ inches = X
12	Type of Cover	Col. 18-19	Code: Spruce (W.C.) - 01 Spr.-Ced.-W.P.-Hem. - 02 Sugar P.-Jeffery-Pond.- 03 Red Fir-D.F.-H.-Cedar-W.F.- 04 Lodgepole - 05 Sub-Alp.-Alp. - 06 Oak-Mahog.-Ching. - 07 Chaparral-Ceanothus - 08 Chemise - 09 Rock Flats-Desert - 10 North Hdwds -- 11 North Hdwd-Conifer - 12 Conifer - 13

Line No. On Tally Sheet	Sample Item	Punch Card Col. No.	Code as Indicated
12 (cont'd)			Apal. Hdwds - 14 Spruce (Eastern) - 15 Pine Hdwds - 16 Spruce Swamp - 17 Jack P., Red and/or White - 18 Aspen - 19 or 29 Rock Flats - 20 Brush (Apal & North Hdwds)- 21 Calif. Woodland - 22 Redwood - 23 Grassland - 24 Manzanita - 25 Sage Brush - 26 Pinon - Juniper - 27 Mesquite - 28 Willow - 30 (Others may be added as required.)
13	Cond. of Cover	Col. 20	Code: Green - 1 0-20% Dead - 2 21-40% Dead - 3 41-60% Dead - 4 61-80% Dead - 5 81-100% Dead - 6
14	Trees Per Sta. (66 Foot Strip)	Col. 21	Code: 0-10 = 1 51-60 = 6 11-20 = 2 61-70 = 7 21-30 = 3 71-80 = 8 31-40 = 4 81-90 = 9 41-50 = 5 91 & Over = 0 R = none
15	Av. D.B.H.	Col. 22	Code: Reprod. Saplings = 1 0-7.9 = 2 8-15.9 = 3 16-23.9 = 4 24-31.9 = 5 32-39.9 = 6 40-47.9 = 7 48-55.9 = 8 56-73.9 = 9 74 & Larger = 0 Zero = x
16	Air-Line Miles to Nearest Road	Col. 23	Code: Less than 3 = 1 3+ to 6 = 2 6+ to 9 = 3 9+ to 12 = 4 12+ to 15 = 5 15+ to 18 = 6 18+ to 21 = 7 Over 21 = 8
17	Air-Line Miles to Nearest Trail	Col. 24	Code: 1 or less than 1 = 1 All others to nearest even mile.

Line No. On Tally Sheet	Sample Item	Punch Card Col. No.	Code as Indicated
18	Lin. Ft. Stringer Bridge	Col. 25-26-27	Code: Actual
19	Lin. Ft. Susp. or Truss Bridge	Col. 28-29-30	Code: Actual
20	Actual Freq. of Clearing	Col. 31	Code: Actual Number in Years 0 = not at all
21	Req. Freq. of Clearing	Col. 32	Code: Actual Number in Years R = Unnecessary
22	Actual Freq. of Grading	Col. 33	Code: Actual Number in Years x = unknown R = not necessary
23	Req. Freq. of Grading	Col. 34	Code: Actual Number in Years R = unnecessary
24	Examiner's Est. Man Hours Mtce. Req. Per Yr.	Col. 35	Code: Less than 2 = 1 2+ to 4 = 2 4+ to 6 = 3 6+ to 8 = 4 8+ to 10 = 5 10+ to 15 = 6 15+ to 20 = 7 20+ to 25 = 8 25+ to 50 = 9 50+ to 100 = 0 100+ to 150 = R x = unknown
25	Ranger Est. Man Hours Mtce. Req. Per Yr.	Col. 36	Code: Same as Col. 35 x = unknown
26	Man Hours in Last Mtce.	Col. 37	Code: Same as Cols. 35 & 36 x = unknown
27	Trail Mted This Yr.	Col. 38	Code: Yes = 1 No = 2
28	Area Grazed by Livestock	Col. 39	Code: Light = 1 Moderate = 2 Heavy = 3 Not at all = 4
29	Condition of Signing	Col. 40	Code: None = 0 Poor = 1 Fair = 2 Good = 3
30	Location of Trail	Col. 41	Code: Valley Bottom = 1 Side Hill = 2 Ridge Top = 3 Canyon Bottom = 4
31	Est. of Constr. Cost (In Man Days Per Mile)	Col. 42-43-44	Code: Actual Man Days
32	Est. Man D. of Betterment (Per Mi.)	Col. 45-46-47	Code: Actual M.D.
33	Miles Relocation replacement needed	Cols. 48-49	Code: Miles & Tenths
34	Classif. of trail	Col. 50	Code: Trunk = 1 Driveway= 2 Connecting = 3 Special = 4
35	Easy-Difficult Areas	Col. 51	Code: Easy = 1 Difficult= 2

Use soft lead pencil. Always complete Col. by filling in 0, i.e. -- 01, 010, 045.

SUPPLEMENT TO CODE FOR NATIONAL TRAIL STUDY

R1		R2		R3	
1.	Beaverhead	Harney	01	1.	Apache
2.	Bitterroot	Black Hills	02	2.	Carson
3.	Cabinet	Shoshone	03	3.	Cibola
4.	Clearwater	Bighorn	04	4.	Coconino
5.	Coeur d'Alene	Medicine Bow	05	5.	Coronado
6.	Colville	Arapaho	06	6.	Crook
7.	Custer	Routt	07	7.	Gila
8.	Deerlodge	Gunnison	08	8.	Kaibab
9.	Flathead	White River	09	9.	Lincoln
10.	Gallatin	Grand Mesa	10	10.	Prescott
11.	Helena	Roosevelt	11	11.	Santa Fe
12.	Kaniksu	Pike	12	12.	Sitgreaves
13.	Kootenai	San Isabel	13	13.	Tonto
14.	Lewis & Clark	Rio Grande	14		
15.	Lolo	Montezuma	15		
16.	Nez Perce	Uncompahgre	16		
17.	St. Joe	San Juan	17		
		Nebraska	18		

R4		R5		R6	
Dixie	01	1.	Angeles	Fremont	01
Fishlake	02	2.	Cleveland	Deschutes	02
Manti	03	3.	Eldorado	Ochoco	03
Uinta	04	4.	Inyo	Malheur	04
Ashley	05	5.	Klamath	Umatilla	05
Wasatch	06	6.	Lassen	Whitman	06
Cache	07	7.	Los Padres	Wallowa	07
Caribou	08	8.	Mendocino	Siskiyou	08
Nevada	09	9.	Modoc	Rouge River	09
Humboldt	10	10.	Plumas	Umpqua	10
Toiyabe	11	11.	San Bernardino	Siuslaw	11
Minidoka	12	12.	Sequoia	Willamette	12
Bridger	13	13.	Shasta	Columbia	13
Targhee	14	14.	Sierra	Mt. Hood	14
Teton	15	15.	Stanislaus	Wenatchee	15
Sawtooth	16	16.	Tahoe	Snoqualmie	16
Boise	17	17.	Trinity	Mt. Baker	17
Payette	18			Chelan	18
Challis	19			Olympia	19
Salmon	20				

SUPPLEMENT TO CODE FOR NATIONAL TRAIL STUDY
(Code Numbers for Forests to be Studied in 1947)

R7		R8		R9	
White Mountain	01	Sumter	01	Mark Twain	01
Allegheny	02	Francis Marion	02	Clark	02
Green Mountain	03	Croatan	03	Shawnee	03
Monongahela	04	Pisgah	04	Hoosier	04
Cumberland	05	Cherokee	05	Wayne	05
Geo. Washington	06	Nantahala	06	Manistee	06
Jefferson	07	Chattahoochee	07	Huron	07
		Bankhead	08	Upper Michigan	08
		Holly Springs	09	Nicholet	09
		Talladega	10	Ottawa	10
		Delta	11	Chequamegon	11
		Bienville	12	Chippewa	12
		Conecuh	13	Superior	13
		Apalachicola	14		
		Osecola	15		
		Ocala	16		
		Desota	17		
		Homochitto	18		
		Kisatchie	19		
		Angelina	20		
		Sabine	21		
		David Crockett	22		
		Sam Houston	23		
		Ozark	24		
		Ouachita	25		

MAINTENANCE ESTIMATE
(on-the-ground work)

Region 1

Forest Groups	Gross Area (1000 acres)	(a) Mi. of existing trail	(b) Miles per sq. mi.	Miles of trail examined	Percentage sampled	Total Est. Mi. in "Easy-Difficult" classif.		Distribution of Miles Examined by man(2) Examiners Estimate 0	1	2	3	5	7	9	12.5	17.5	22.5	37.5	Estimate-man hrs. per mi. per yr. to maintain (3) Examiner
(1)																			
Beaverhead - Deerlodge	3547	1728	0.31	63	3.65	Easy	783		6	13	10	2							
						Diff.	945		3	10	8	8	3						2.00
Bitterroot	2002	2987	0.95	134	4.49	Easy	508		3	32	12	10	7	0	0	0	4	0	
						Diff.	2479		0	14	16	17	10	2	0	0	4	3	6.41
Cabinet - Lolo	3586	5370	0.96	163	3.03	Easy	2426		0	23	38	17	5	4	4	1	0	0	
						Diff.	2944		0	11	22	16	8	8	3	2	0	1	5.02
Clearwater - St. Joe	2234	4303	1.24	164	2.62	Easy	1066		1	8	19	11	5			1			
						Diff.	3237		1	7	33	31	18	17	7	1	1	3	5.41
Coeur d'Alene	802	1516	1.21	57	3.76	Easy	793	oo4	0	1	5	5	8	0					
						Diff.	723	oo7	0	0	6	13	3	5					4.32
Custer - Gallatin	3406	3009	0.56	105	3.49	Easy	1346		20	41	21	1							
						Diff.	1663		2	10	5	5							2.47
Flathead	2623	4497	1.09	155	3.45	Easy	1716		0	69	30	8	2	2	3	2	0	0	
						Diff.	2781			4	14	16	3	0	0	0	1	1	4.58
Helena - Lewis & Clark	3182	3210	0.65	117	3.64	Easy	2377		16	42	11	2	0						
						Diff.	833			27	16	0	0	2	1				2.24
Kaniksu - Colville	2359	3973	1.08	102	2.57	Easy	1780		1	8	23	8	4			1		1	
						Diff.	2193			6	19	11	8	6	4			2	5.57
Kootenai	2103	3261	0.99	114	3.49	Easy	1989			54	21	4	3	1					
						Diff.	1272			20	8	3	0	0					2.62
Nez Perce	1976	3298	1.07	85	2.58	Easy	592		1	14	6	2	0	1					
						Diff.	2706		1	10	16	19	11	1	1	1	1		4.56
Totals	27820	37152	0.85	1259	3.39	Easy	15376	oo4	48	305	196	70	34	8	7	5	4	1	
						Diff.	21776	oo7	7	119	163	139	64	41	16	4	7	10	4.44
							37152	11	55	424	359	209	98	49	23	9	11	11	

oo Carried on trail system but actually is abandoned because of parallel roads. No maintenance ever done on these miles.

(1) Examinations were made on underscored forest.

(2) Estimates are for "work on the ground" and do not include (a) travel time except once over, (b) bridges that would be constructed and maintained on project basis, (c) special equipment, (d) signs, (e) transportation, (f) supervision, and (g) leave. (hrs. per mi. per yr. to maintain)

(3) Weighted proportional to the mileage in "Easy" and "Difficult" classifications.

MAINTENANCE ESTIMATE
(On-the-ground Work)

Region 5

Forest Groups	Gross Area (1000 acres)	(a) Mi. of existing trail	(b) Miles per sq. mi.	Miles of trail examined	Percentage sampled	Total Est. Mi. in "Easy-Difficult" classif.		Distribution of Miles Examined by man (2) Examiners Estimate 0	1	2	3	5	7	9	12.5	17.5	22.5	37.5	Estimate man hrs. per mi. per yr. to maintain (3) Examiner
(1)																			
Angeles - Cleveland - Las Padres - San Bernardino	4078	3510	0.55	142	4.05	Easy	500		6	23	10	1			1	2	2		
						Diff.	3010		6	12	22	13	13	18	7	4	2		6.01
Eldorado - Stanislaus	1968	2137	0.69	92	4.30	Easy	1389			20	20	16	3	1					
						Diff.	748			11	7	11	3						3.58
Inyo - Sierra - Sequoia	4273	3831	0.52	104	3.01	Easy	2296		3	9	27	17	2	0	1				
						Diff.	1585			1	14	14	6	4	4	2			4.66
Klamath	1701	2345	0.38	97	4.14	Easy	1553			2	32	20	7	1	2	1	0	0	
						Diff.	792			4	1	7	5	9	1	1	0	4	6.67
Lassen - Plumas - Modoc - Tahoe	5915	2754	0.29	92	3.54	Easy	1799			9	24	7	4						
						Diff.	955			2	25	15	6						3.79
Mendocino - Trinity	2790	3720	0.86	136	3.66	Easy	1978			42	33	9							
						Diff.	1742			8	24	15	5						3.23
Shasta	1913	1952	0.65	116	5.94	Easy	1254			2	17	16	6	4	5	2	0	2	
						Diff.	698			2	6	12	17	9	9	6	1	0	7.60
Totals & Averages	22638	20299	0.56	779	3.92	Easy	10769		9	107	163	86	22	6	9	5	2	2	
						Diff.	9530		6	40	99	87	55	40	21	13	3	4	5.05
							20299		15	147	262	173	77	46	30	18	5	6	

(1) Examinations were made on underscored forest.

(2) Estimates are for "work on the ground" and do not include (a) travel time except once over, (b) bridges that would be constructed and maintained on project basis, (c) special equipment, (d) signs, (e) transportation, (f) supervision, and (g) leave. (hrs. per mi. per yr. to maintain)

(3) Weighted proportional to the mileage in "Easy" and "Difficult" classifications.

MAINTENANCE ESTIMATE
(On-the-ground Work)

Region 6

Forest Groups ((1))	Gross Area (1000 acres)	(a) Mi. of existing trail	(b) Miles per sq. mi.	Miles of trail examined	Percentage sampled	Total Est. Mi. in "Easy-Difficult" classif.		Distribution of Miles Examined by man((2)) Examiners Estimate 0	1	2	3	5	7	9	12.5	17.5	22.5	37.5	Estimate man hrs per mi. per yr. to maintain ((3)) Examiner
(1) Mt. Hood	1184	1939	1.05	73	3.76	Easy	272				8	5	2						
						Diff.	1667			4	7	36	11						4.83
(2) Chelan (1)	2090	2617	0.80	91	3.48	Easy	864												
						Diff.	1753		6	7	20	30	16	4	2	4	2		4.39
(3) Wenatchee	1521	2274	0.96	80	3.52	Easy	591		4	13									
						Diff.	1683			1	9	15	9	10	8	6	2	3	7.73
(4) Willamette	1819	2982	1.05	99	3.32	Easy	1312			8	12	6	4	1	1	2			
						Diff.	1670		4	1	26	17	15		2				4.73
(5) Rogue River-Umpqua	2412	2818	0.80	92	3.26	Easy	1505			4	11	7	1	3					
						Diff.	1513			52	5	2	5	1	1				3.57
(6) Siskiyou-Siuslaw	2584	2202	0.54	81	3.68	Easy	396			3	4	7	4	1					
						Diff.	1806			2	26	26	6	2					4.45
(7) Columbia-Olympia	2127	2656	0.80	91	3.43	Easy	1820			11	19	18	9	2					
						Diff.	836				3	14	7	5	3				4.98
(8) Snoqualmie-Mt. Baker(2)	3389	3198	0.60	76	2.38	Easy	703												
						Diff.	2495			4	31	11	5	1	12	8	4		6.88
(9) Umatilla-Ochoco-Whitman	4003	2523	0.40	55	2.19	Easy	1647		4	2	3								
						Diff.	876		1	12	20	6	5	1	1				2.39
(10) Wallowa-Deschutes Fremont-Malheur	6062	2941	0.31	91	3.09	Easy	1274			14								1	
						Diff.	1667			22	19	20	5	7	1	1	1		4.52
TOTALS	27191	26350	0.62	829	3.15	Easy	10384		8	55	57	43	20	7	1	2		1	
						Diff.	15966		11	105	166	177	84	31	30	19	9	3	4.94

(1) Chelan "Easy" at same rate as Wenatchee "Easy".
(2) Snoqualmie "Easy" at same rate as Columbia "Easy".

((1)) Examinations were made on underscored forest.
((2)) Estimates are for "work on the ground" and do not include (a) travel time except once over, (b) bridges that would be constructed and maintained on project basis, (c) special equipment, (d) signs, (e) transportation, (f) supervision, and (g) leave. (hrs. per mi. per yr. to maintain)
((3)) Weighted proportional to the mileage in "Easy" and "Difficult" classif.

MAINTENANCE ESTIMATE
(On-the-ground Work)

Region 2

Forest Groups	Gross Area (1000 acres)	(a) Mi. of existing trail	(b) Miles per sq. mi.	Miles of trail examined	Percentage sampled	Total Est. Mi. in "Easy-Difficult" classif.		Distribution of Miles Examined by men(2) Examiners Estimate 0	1	2	3	5	7	9	12.5	17.5	22.5	37.5	Est. man hrs. per mi. per yr. to maintain (3) Examiner
(1) Grand Mesa-Black Hills							Easy	1551		19	14	4	1	2	1				2.25
Medicine Bow°-Routt	3539	2197	0.40	77	2.85		Diff.	646		7	15	7	7						
(2) Montezuma-Uncompahgre							Easy	1420			33	7	1	3					3.26
Gunnison	3255	2933	0.58	92	3.14		Diff.	1513			11	17	13	7					
							Easy	1232		15	3	9	5	1					2.70
(3) Rio Grande-San Juan	3328	3098	0.60	71	2.29		Diff.	1866		13	4	12	6	2	1				
(4) San Isabel-Arapaho							Easy	1450			22	23	7	2		1		1	3.25
Harney-Pike-Roosevelt	5412	2705	0.32	88	3.25		Diff.	1255			10	19	2	1					
							Easy	1511		8	5	15	7	2	3	1			4.53
(5) Shoshone-Big Horn	3580	2798	0.50	82	2.93		Diff.	1287		8	1	7	10	7	4	2	2		
							Easy	1042		4	26	17	3						3.22
(6) White River	2092	2266	0.69	92	4.06		Diff.	1224		3	17	4	12	4	1		1		
TOTALS	21206	15997	0.48	502	3.14		Easy	8206		46	103	75	24	10	4	2		1	
							Diff.	7791		31	58	66	50	21	6	2	3		3.25
°Does not include 453648 acres with no trails.																			
Region 3																			
Apache - Gila(1) - Lincoln	5620	3218	0.36	120	3.73		Easy	205		10	5								
							Diff.	3013		4	21	24	47	9					3.79
Carson - Cibola - Santa Fe	4860	3538	0.46	116	3.27		Easy	117		4	6	1							
							Diff.	3421		26	60	17	1	1					1.98
Coconino - Kaibab -	7691	3333	0.28	155	4.62		Easy	202		0	12	0	1	0	0	0			
Prescott - Tonto							Diff.	3131		2	42	36	40	11	9	2			3.95
Coronado - Crook	2951	2302	0.50	91	3.95		Easy	-		-	-	-	-	-	-	-			
							Diff.	2302		6	40	27	10	3	4	1	-	- -	3.15
Totals & Averages	21122°°	12391	0.38	482	3.88		Easy	524		14	23	1	1	0					
°°Does not include Sitgreaves with no trail.							Diff.	11867		38	163	104	98	24	13	3			
								12391		52	186	105	99	24	13	3			3.29

(1) Examinations were made on underscored forest.

(2) Estimates are for "work on the ground" and do not include (a) travel time except once over, (b) bridges that would be constructed and maintained on project basis, (c) special equipment, (d) signs, (e) transportation, (f) supervision, and (g) leave. (hrs. per mi. per yr. to maintain)

(3) Weighted proportional to the mileage in "Easy" and "Difficult" classifications.

MAINTENANCE ESTIMATE
(On-the-ground Work)

Region 4

Forest Groups (1)	Gross Area (1000 acres)	(a) Mi. of existing trail	(b) Miles per sq. mi.	Miles of trail examined	Percentage sampled	Total Est. Mi. in "Easy-Difficult" classif.		Distribution of Miles Examined by man(2) Examiners Estimate 0	1	2	3	5	7	9	12.5	17.5	22.5	37.5	Est. man hrs. per mi. per yr. to maintain(3) Examiner
(1) Boise	2951	2807	0.61	111	3.95	Easy	1319			17	9	5							2.99
						Diff.	1488			23	40	15	2						
(2) Challis-Sawtooth	3714	3904	0.67	112	2.87	Easy	1593			4	1								
						Diff.	2311			16	33	22	16	6	6	7		1	4.45
(3) Payette	2419	3368	0.89	113	3.36	Easy	1347		3	2		1							
						Diff.	2021		2	40	24	20	9	6	5	1			3.33
(4) Salmon	2074	2442	0.76	79	3.24	Easy	562		4	7									
						Diff.	1880		6	12	10	18	10	10	1	1			4.22
(5) Targhee-Cache-Caribou	3637	2402	0.42	70	2.91	Easy	1522		1	31	4								
						Diff.	880		1	17	8	5	1	2					2.63
(6) Toiyabe-Humboldt Minidoka-Nevada	6551	2535	0.25	63	2.49	Easy	1424		23	2	1								
						Diff.	1111		14	12	9	2							1.54
(7) Dixie-Fishlake-Manti	4251	2711	0.41	77	2.84	Easy	1331		4	33	2	2							
						Diff.	1380		8	20	7	1							2.08
(8) Uinta-Ashley-Wasatch	3654	3311	0.58	118	3.56	Easy	1759			38	9	6	1						
						Diff.	1552			20	21	16	3		4				3.24
(9) Bridger-Teton	3437	3477	0.65	78	2.24	Easy	1798		17	1	1								
						Diff.	1679		12	6	18	17	4	2					2.31
TOTALS	32688	26957	0.53	821	3.05	Easy	12655		52	135	27	14	1						
						Diff.	14302		43	166	170	116	45	26	16	9		1	3.16

(1) Examinations were made on underscored forest.

(2) Estimates are for "work on the ground" and do not include (a) travel time except once over, (b) bridges that would be constructed and maintained on project basis, (c) special equipment, (d) signs, (e) transportation, (f) supervision, and (g) leave. (hrs. per mi. per yr. to maintain)

(3) Weighted proportional to the mileage in "Easy" and "Difficult" classif.

MAINTENANCE ESTIMATE
(On-the-ground Work)

Region 7

Forest Groups°	(3) Gross Area (1000 acres)	(a) Mi. of existing trail	(b) Miles per sq. mi.	Miles of trail examined	Percentage sampled	Total Est. Mi. in "Easy-Difficult" classif.	Distribution of Miles examined by man°° Examiners Estimate 0	1	2	3	5	7	9	12.5	17.5	22.5	37.5	Est. man hrs. per mi. per yr. to maintain°°° Examiner
White Mtn. - Green Mtn.	872	984	0.72	56	5.69		-	10	44	2	-	-	-	-	-	-		2.89
Alleghany - Monongehela	1264	1150	0.58	28	2.43	Not	-	13	14	1	-	-	-	-	-	-		2.61
Jefferson	549	879	1.02	40	4.55	Classified	-	13	18	4	-	-	-	-	-	-		2.75
Geo. Washington	922	1192	0.83	77	6.46		-	40	27	10	-	-	-	-	-	-		2.74
Totals	3607	4205	0.74	201	4.78		-	81	103	17	-	-	-	-	-	-		2.77

Region 8 (1)

Nantahala-Sumter	730	376	0.33	32	8.51		-	(4)	10	17	5	-	-	-	-	-		3.00
Pisgah	472	644	0.87	63	9.78	Not	4	21	19	17	2	-	-	-	-	-		3.14
Cherokee	565	583	0.66	66	11.32	Classified	-	41	25	-	-	-	-	-	-	-		2.38
Chattahoochee	653	183	0.18	32	17.49		-	(4)	2	14	15	1	-	-	-	-		4.00
Totals	2420	1786	0.47	193	10.81		4	(4)	74	75	37	3	-	-	-	-		3.00

Region 9 (1)

Superior(5)-Ottawa	1802 (2)	948	0.34	51	5.38	Not classified	-	3	16	20	8	4	-	-	-	-		4.82

(1) Only forests included are those with an existing reportable trail system.
(2) Includes no Ottawa acreage - only 62 miles of trail on unit.
(3) Includes only area under F.S. Admin.
(4) 4 miles with no maintenance.
(5) Special charges for mtce. of docks and canoe rests to be added to usual Indirect charges.
°Examinations were made on underscored forest.
°°Estimates are for "work on the ground" and do not include (a) travel time except once over, (b) bridges that would be constructed and maintained on project basis, (c) special equipment, (d) signs, (e) transportation, (f) supervision, and (g) leave. (hrs. per mi. per yr. to maintain)
°°°Weighted proportional to the mileage in "Easy" and "Difficult" classifs.

ERRORS OF MEAN ESTIMATE

The errors of mean estimate were calculated from the estimates on all miles observed but without weighting the estimates proportionate to the mileage in "Easy" and "Difficult" (to maintain) areas. It would have required a lot of calculation to reduce mileages to these proportions and without producing any additional value to justify it. However, one such calculation was made as a check. The Flathead had the biggest relative difference between the arithmetic mean and the weighted mean estimate of any forest examined in 1946. The comparative figures for it follow:

> Arithmetic mean estimate 3.76 man hours per mile ± 0.97
> or error 25.7%
> Weighted mean estimate 4.40 man hours per mile ± 1.16
> or error 26.4%

This indicates that the percentages of error from the weighted and unweighted means are substantially the same for any unit under consideration.

Likewise the errors of rangers' mean estimate were not calculated. The biggest relative difference between rangers' and examiners' estimate was on the Tahoe. The differences in rangers' and examiners' estimates were so insignificant in 1947 that it was decided to leave the former out of this report entirely. The comparative figures are as follows:

> Examiners' mean estimate -- 3.79 ± 0.46 -- error 12.1%
> Rangers' mean estimate -- 4.66 ± 1.02 -- error 21.9%

The table below summarizes all the data on errors of estimate. It indicates that:

1. The samples taken are adequate in number if they represent true samples for forest and region respectively. The question has not been seriously raised anywhere that they are other than representive samples.

2. Some field work could probably have been eliminated and more should have been done on a few units (e.g. Bitterroot, Klamath, Wallowa, San Isabel) to have gotten the best results. However, theoretically the number of samples must be doubled to reduce the error of mean estimate by half and it was wholly impractical to make such changes in plans once the work was under way.

3. The figures mean for the Kootenai Forest, for example, that if all the trails on the forest had been examined the mean estimate of man hours per mile per day for "on-the-ground" work would have been 2.62 ± 13% or between 2.28 and 2.96

The summary follows:

Errors of Estimate-Maintenance

(arranged in order of dependability of estimate)

"on-the-ground" work time.

	Forest Groups	Estimated man hours per mi. per yr. (weighted)	Percentage of Error
	Region 1		
1.	Kootenai	2.62	13
2.	Gallatin-Custer	2.47	13
3.	Clearwater-St. Joe	5.41	14
4.	Kaniksu-Colville	5.57	16
5.	Lewis & Clark-Helena	2.24	17
6.	Coeur d'Alene	4.32	20
7.	Lolo-Cabinet	5.02	20
8.	Beaverhead-Deerlodge	2.90	20
9.	Nezperce	4.56	24
10.	Flathead	4.58	26
11.	Bitterroot	6.41	32
	Region 1 37,152 miles	4.44	8.9
	Region 5		
1.	Trinity-Mendocino	3.23	10
2.	Tahoe-Lassen-Plumas-Modoc	3.79	12
3.	Stanislaus-Eldorado	3.58	14
4.	Sierra-Inyo-Sequoia	4.66	19
5.	Shasta	7.60	21
6.	Los Padres-Angeles-Cleveland-San Bernardino	6.01	22
7.	Klamath	6.67	32
	Region 5 20,299 miles	5.05	9.6
	Region 6		
1.	Mt. Hood	4.83	10
2.	Siskiyou-Siuslaw	4.45	13
3.	Columbia-Olympia	4.98	15
4.	Willamette	4.73	19
5.	Rogue River-Umpqua	3.57	21
6.	Chelan	4.39	24
7.	Umatilla-Ochoco-Whitman	2.39	25
8.	Snoqualmie-Mt. Baker	6.88	27
9.	Wenatchee	7.73	32
10.	Wallowa-Deschutes-Fremont-Malheur	4.52	33
	Region 6 26,350 miles	4.94	8.8
	Region 2		
1.	Montezuma-Uncompahgre-Gunnison	3.26	16
2.	White River	3.22	22
3.	Grand Mesa-Routt-Black Hills-Medicine Bow	2.25	23
4.	Rio Grande-San Juan	2.70	24
5.	Shoshone-Bighorn	4.53	25
6.	San Isabel-Pike-Arapaho-Roosevelt-Harney	3.25	39
	Region 2 15,997 miles	3.24	4.8

2-Errors of Estimate-Maintenance

Forest Groups		Estimated man hours per mile per year (weighted)	Percentage of Error
Region 3			
1. Carson-Cibola-Santa Fe		1.98	12
2. Gila-Apache-Lincoln		3.79	13
3. Tonto-Coconino-Kaibab-Prescott		3.95	14
4. Crook-Coronado		3.15	21
Region 3	12,391 miles	3.29	8.4
Region 4			
1. Boise		2.99	11
2. Dixie-Fishlake-Manti		2.08	13
3. Uinta-Wasatch-Ashley		3.24	18
4. Targhee-Cache-Caribou		2.49	20
5. Toiyabe-Humboldt-Minidoka-Nevada		1.54	22
6. Challis-Sawtooth		4.45	23
7. Payette		3.33	21
8. Salmon		4.22	23
9. Teton-Bridger		2.31	23
Region 4	26,957 miles	3.16	6.3
Region 7			
1. George Washington		2.74	12
2. Jefferson		2.75	15
3. Monongahela		2.61	15
4. White Mountain-Green Mountain-Allegheny		2.89	8
Region 7	4,205 miles	2.77	6.3
Region 8			
1. Chattahoochee		4.00	16
2. Cherokee		2.38	7
3. Nantahala		3.00	17
4. Pisgah		3.14	19
Region 8	1,951 miles	3.00	9.1
Region 9			
1. Superior		4.82	16.6
Region 9	948 miles	4.82	

Special Items of Maintenance Cost

Bridges: Suspension, truss and long (generally more than one 30' bent) stringer bridges usually requiring the services of a special crew to construct or maintain, were excluded from the mile by mile estimate but a record was kept of the length of those observed on sample mileage. The estimate of length is as follows:

Region	Feet	Estimated Annual Mtce.*	Mtce. cost per mile per yr. (Chargeable against entire system)
1	8545	6409	$.17
2	0	0	0
3	0	0	0
4	10230	9172	.34
5	3045	2284	.11
6	9917	7438	.28
7	0	0	0
8	0	0	0
9	0	0	0

*2½% of construction cost estimated at $30 per foot.

Signs: The number of directional signs required is directly related to the intensity of the trail system. The minimum requirements are shown in the following table:

Sign Requirements

Miles of Trail per 100 sq. mi.	No. of Directional Trail Signs per 100 mi. of trail
30	12
40	17
50	24
60	28
70	33
80	39
90	44
100	50
110	56

Policy varies widely between regions on placement of informational signs on trails. Good signing practice indicates one informational sign for each three directional signs on the average.

For the average intensity of the system by regions, requirements are estimated as follows:

Region	Mi. of Trail per sq. mi.	Directional Signs per mi. of Trail**	Cost per mile per year***
1	0.85	.43	$ .09
2	0.47	.21	.04
3	0.36	.16	.03
4	0.53	.24	.05
5	0.57	.27	.05
6	0.62	.29	.06
7	0.34*	.14	.03
8	0.25*	.10	.02
9	0.20*	.08	.02

*Calculated against only those forests having any trails.
**Does not include signs on roads directing to trails.
***Cost per sign is estimated at $1.00 for aluminum signs with replacement at 5-year intervals or 20 cents per sign per year. Wood and other types of rustic sign will cost from two to four times as much.

* * * *

Transportation: A. Three animals per maintenance crew are regarded as about minimum no matter whether moving is by a packer (part time) or by a member of the crew full time. Costs are estimated as follows per animal:

Depreciation - $150 - 10 years	$15.00 annual	
Maintenance:		
Hay	27.00	
Oats	34.00	
Pasture	14.00	
Pack equip., rigging, etc.	15.00	
Shoes and shoeing	12.00	
Cost per animal	117.00	
Per crew (3 animals)		$351.00

In order to convert this to a cost-per-mile basis, a June 1-September 30 work season is used with 87 work days. The rate of progress with 2-man crews doing "on-the-ground" work (or equivalent in deferred work) should be on the average:

Region	Miles per season mtd. by crew	Cost per mile - horse transp. $351 ÷ mi. mtd. per season per crew
1	87 x (16 ÷ 4.44)* = 313	$1.12
2	" " 3.25 = 428	.82
3	" " 3.29 = 423	.83
4	" " 3.16 = 441	.80
5	" " 5.05 = 276	1.27
6	" " 4.94 = 282	1.24
7	" " 2.77 = 502	.70
8	" " 3.00 = 464	.76
9	" " 4.82 = 289	1.21

*Man hours per mile per year for "on-the-ground" maintenance.

These costs are not directly applicable in Regions 7, 8 and 9 where horses are seldom or never used in maintenance. The estimate is believed to be applicable in that comparable or greater costs will be incurred in other forms of transportation, increased travel time or some other offsetting factor.

B. Trucking and hauling costs are estimated as follows:

One truck servicing 4 camps every ten days — mileage per circuit trip — 100 equals 300 miles per month, or 75 miles per camp per month at $.15 for operation, repair, and depreciation on vehicle plus 2 days time of driver each 10 days or 1½ days per camp per month.

Per Month per Camp - Truck, $11.25 - Driver, $15.00 = $26.25.
Cost per Season - $26.25 x 4 = $105.00

Charging this back against mileage per crew season in the same way as for animal transportation, the estimate is:

Region	Trucking cost per mi.
1	$.34
2	.25
3	.25
4	.24
5	.38
6	.37
7	.21
8	.23
9	.36

And estimated total transportation cost per mile of:

Region	Cost per mile		Total cost per mile (Transportation)
	animal trans.	trucking, etc.	
1	$ 1.12	$ 0.34	$ 1.46
2	.82	.25	1.07
3	.83	.25	1.08
4	.80	.24	1.04
5	1.27	.38	1.65
6	1.24	.37	1.61
7	.70	.21	.91
8	.76	.23	.99
9	1.21	.36	1.57

Equipment: This estimate includes: 1 cross-cut saw, $3.75; 3 axes, $5.85: 3 shovels, $4.95; 1 single jack, $1.20; 1 stove, $15.00; 2 shears, $6.00; 2 tents, $80.00; misc., $10.00 = $127.65 to be depreciated in 3 years or $42.55 per year. Trail plow, $18.00; trail grader, $17.00; cook outfit, $14.00; 3 kapok beds, $11.75; misc., $6.00, total $66.75 to be depreciated in 6 years or $11.12 per year.

Total per crew per year - $42.55 plus $11.12 = $53.67

Charging this off against crew mileage in the same manner as was done in transportation, the estimate becomes:

Region	Cost per mi. per yr. for equipment
1	$.17
2	.13
3	.13
4	.12
5	.19
6	.19
7	.11
8	.12
9	.19

* * * *

Travel Time: The lowest possible travel time on trail work is with one man operating alone and moving camp daily, by some means, to the end of the day's work. Few men will work alone and for that reason, as well as reasons of safety, this type of crew is not generally practicable.

A two men "gypsy" crew (same as above) is tne next most effective from the standpoint of losses due to travel time. It is recommended particularly in situations where cabins or shelters can be stocked in advance for workers.

The next most effective is a 2-man crew moved by a packer who can often service two or more camps and handle other administrative packing as well. Comparable to this is a 3-man crew with one man moving camp, cooking and doing such trail work as time permits. Often this resolves itself into two men working and the third occupied exclusively with camp duties - in short with one-third of the manpower engaged so as to eliminate all or nearly all unproductive travel time for the two workers. Larger crews are wasteful of travel time unless there is a large volume of work per mile.

Much more attention should be paid to this phase of trail work. There are many situations, where the volume of work per mile is light, in which crews are literally being paid for a walking vacation.

The estimates for travel time are based on such data as were available in the field plus theoretical considerations, taking into account distance

between camps, type of organization and size of crews. It may be stated as an axiom that travel time both ways will increase the cost of "on-the-ground" trail maintenance by not less than 25% under any of the conditions by which the work is ordinarily done. After carefully considering modes of transportation, camping sites, availability of water and forage by regions, the values assigned are:

Region	% "on-the-ground" work is increased acct. Travel Time (both ways)	"on-the-ground" cost to which % of increase applies*	cost per mi. per year both ways	cost per mi. per year one way only
1	35	$ 5.11	$ 1.79	$ .89
2	30	3.74	1.12	.56
3	40	3.78	1.51	.76
4	35	3.63	1.27	.64
5	30	5.81	1.74	.87
6	35	5.68	1.99	.99
7	30	3.19	.96	.48
8	30	3.45	1.03	.52
9	40	5.54	2.22	1.11

*"on-the-ground" work evaluated at $1.15 per hour.

There appears to be no uniformity of practice in paying for travel time within regions or sometimes even on ranger districts on the same forests, but travel one way on government time comes nearest to being common practice.

* * * *

Lost Time: Lost time due to inclement weather and the like is usually considered to be made up by workers, or lost. In fact, it probably is less often than not and almost certainly not except where crews come off the job during working hours. The loss is believed to be highest in a "continental" rainfall type. A detailed examination of rainfall records at Asheville, N.C. and Elkins, W. Va. (with about maximum summer precipitation) was made for the period 1935-44 to get frequency and length of periods of precipitation and the amounts, between 8:00 AM and 5:00 PM. It shows that during working hours from April through September inclusive it is raining 8.3% and 9.1% of the time respectively at these two stations.

About 2/3 of these storms are of less than 3 hours' duration and about 3/4 of the precipitation time is in storms of less than .10" Total - both of a nature that would cause men to quit work and scurry for temporary shelter but not to leave the job.

It is therefore estimated that a minimum of about 3/4 of 9% or say 7% of paid work time is lost. On the assumption that the losses are relatively comparable elsewhere, precipitation indexes were developed for other regions weighted proportional to trail distribution within each region. They are as follows with the loss converted to cost per mile in the fourth column:

Region	Weighted Precipitation Index *	Estimated Loss of Time Due to Weather (percent)	Value of Lost Time Due to Weather (per mile) **
1	1.31	2.38	$ 0.12
2	1.50	2.73	0.10
3	1.85	3.36	0.13
4	0.94	1.68	0.06
5	0.72	1.33	0.08
6	1.79	3.29	0.19
7	3.85	7.00	0.22
8	3.85	7.00	0.24
9	3.20	5.81	0.32

*Average weighted monthly precipitation June-October inclusive for Regions 1-6 inclusive. May-October inclusive for Regions 7, 8 and 9.

**Probably represents an absolute minimum.

* * * *

Miscellaneous Direct Costs (Region 9)

The Superior Forest in Region 9 is unique in the United States. Most of it is a labryrinth of streams connecting literally thousands of lakes. Much of the trail system consists of short portages between waters navigable by canoe or larger boat. Recreation use is heavy and is almost exclusively by boat. This results in three additional items of cost worth noting.

Canoe rests are planned at 50 rod intervals on canoe routes and consist of a horizontal pole about 8 feet in length nailed to a tree 8 or 9 feet above the ground and fitted into a fork or above a limb on a second tree. This prevents the rest from being torn off by wind action. Occasionally they are made with a double A-frame and crossbars.

Two man hours is estimated as the time necessary to construct them and the life is estimated at 10 years or 0.2 man hour per rest per year. Six rests per mile would be necessary to meet the standard of 50 rod intervals. There are 538 portages on 131 portage routes with mileage of 187 or an estimated 1122 canoe rests or 1.27 per mile chargeable against all mileage. Maintenance (replacement) cost is 0.2 x 1.27 or 0.25 man hour or $0.29 per mile per year.

Docks

Simple docks consisting of backfilled log crib are required for most landings. It is estimated that 1.2 docks per portage for 538 portages or 646 docks or 0.73 per mile for total mileage is required. Maintenance for the most part will be replacement every 15 years estimated at one man day or say 0.5 man hour per dock per year or 0.5 x 0.73 equals 0.36 man hour or 0.41 cent per mile per year.

Portages require better tread than any ordinary foot or horse trail as people are packing heavy loads over them requiring exceptionally stable footing. Many, if not most, of them could be negotiated with a bicycle. The best estimate that could be made was that basic maintenance work would be increased by 50% for portage mileage of 187 or 4.82 m.h. x 1/2 equals 241 man hours, which equals 0.51 man hour or 0.59 cent per mile per year for extra work on portages proportioned against total mileage of 886.

Bridges were included in the basic estimate for R9 as all of them seen are simple foot bridges.

Supervision and Training: Adequate supervision of trail maintenance is hard to get and the cost is high for the reason that, on the average, probably twice as much time is spent in travel getting to the job to be supervised as is spent in supervision itself. The volume of work is seldom great enough to put a supervisor out with a crew continuously (except a straw boss who is a working member of a crew of 2 or 3 men).

The least amount of supervisory time of assistant ranger caliber or above that is considered acceptable, is one-half day per crew (of 2 men) every 10 days. With the necessary travel, that would be increased to 2 days at a minimum or a ratio of 2:20 or 10% of total time estimate to be added for this type of supervision. But the rate per hour for assistant ranger at midpoint of P1 is $1.45 or 1.26 times the $1.15 rate used for guard workers. Cost for supervision thus becomes 12.6%. Top level supervision is considered later.

Clerical costs per month are estimated on the average to add up as follows for a 20-man crew (or equivalent in smaller crews):

Payroll	4 days
Hiring, releasing, compensations, etc.	4 "
Supply	4 "
Equipment records, etc.	2 "
Miscellaneous	2 "
Total	16

Figuring 21½ work days per month, the total work days for a 20-man crew are 430. The ratio of clerical to direct work is then 16 : 430 or 3.7%.

No extra item is included for training which should be on the job and therefore not a segregated item. Its importance cannot be overestimated.

It is therefore estimated that supervision, training and clerical will add a minimum of 12.6% plus 3.7% or 16.3% that would apply to the direct items of cost (except transportation and equipment) in the following tabulation.

The summary exclusive of supervision, and leave, is as follows:

Item	Region 1	2	3	4	5	6	7	8	9
"On-the-ground"	$5.11	$3.73	$3.78	$3.63	$5.81	$5.68	$3.19	$3.45	$5.54
Bridges	.17	-	-	.34	.11	.28	-	-	-
Signs	.09	.04	.03	.05	.05	.06	.03	.02	.02
Transportation	1.46	1.07	1.08	1.04	1.65	1.61	.91	.99	1.57
Equipment	.17	.13	.13	.12	.19	.19	.11	.12	.19
Travel (one way)	.89	.56	.76	.64	.87	.99	.48	.52	1.11
Lost Time	.12	.10	.13	.06	.08	.19	.22	.24	.32
Miscellaneous	-	-	-	-	-	-	-	-	1.29
Total	8.01	5.63	5.91	5.88	8.76	9.00	4.94	5.34	10.04

We then have, exclusive of leave:

Region	Annual Maintenance Cost per mile per year: Direct (less transportation & equipment)	Supervision 16.3% Col. 2	Total - Direct & Supervision
1	$6.38	$1.04	$9.05
2	4.43	.72	6.35
3	4.70	.77	6.68
4	4.72	.77	6.65
5	6.92	1.13	9.89
6	7.20	1.17	10.17
7	3.92	.64	5.58
8	4.23	.69	6.03
9	8.28	1.35	11.39

Leave: Is chargeable percentage-wise against all the items entering into the total of the last column of the preceding tabulation except transportation and equipment; that is to say that substantially all of the other items represent expenditures of time.

Annual leave can be calculated at 26 divided by 252 or 10.3% and sick leave for the class of employee under consideration is estimated at 5/252 or 2% or a total of 12.3% chargeable against the last column of the preceding table after excluding equipment and transportation costs. This becomes:

Region	Total - Direct & Supervisory excl. Eq. & Trans.	Amount for Leave	Grand Total inc. Supervision and Leave*
1	$7.42	$0.91	$9.96
2	5.15	0.63	6.98
3	5.47	0.67	7.35
4	5.49	0.68	7.33
5	8.05	0.99	10.88
6	8.37	1.03	11.20
7	4.56	0.56	6.14
8	4.92	0.60	6.63
9	9.63	1.18	12.57

It is interesting to note that the original "on-the-ground" estimates finally are almost exactly doubled after adding in these various cost items. The end result differs widely from some preconceived notions of the examiners, one of which was that the spread between regions would be much greater. These estimates have almost certainly been influenced to some extent by the amount of deferred maintenance observed and probably estimates tend to be inflated in those regions where there is a large amount of this class of work. This does not suggest any revision of the estimates, because all regions have a large volume of it. It may suggest that the estimates are liberal rather than too low.

* * * *

Maintenance

Errors of Estimate - "On-the-Ground" Work Only
(arranged in order of dependability of estimate)

Forest Groups	Estimated man hours per mile per year (weighted	Percentage of Error
Region 1		
1. Kootenai	2.62	13
2. Gallatin-Custer	2.47	13
3. Clearwater-St. Joe	5.41	14
4. Kaniksu-Colville	5.57	16
5. Lewis & Clark-Helena	2.24	17
6. Coeur d'Alene	4.32	20
7. Lolo-Cabinet	5.02	20
8. Beaverhead-Deerlodge	2.90	20
9. Nezperce	4.56	24
10. Flathead	4.58	26
11. Bitterroot	6.41	32
Region 37,152 miles	4.44	8.9

*Note these figures are subject to correction for differences, if any, in wage scale from region to region. These scales were not available while this report was being prepared, hence the corrections will appear in the body of this report.

	Forest Groups	Estimated man hours per mile per year (weighted)	Percentage of Error
	Region 5		
1.	Trinity-Mendocino	3.23	10
2.	Tahoe-Lassen-Plumas-Modoc	3.79	12
3.	Stanislaus-Eldorado	3.58	14
4.	Sierra-Inyo-Sequoia	4.66	19
5.	Shasta	7.60	21
6.	Los Padres-Angeles-Cleveland-SanBernardino	6.01	22
7.	Klamath	6.67	32
	Region 20,299 miles	5.05	9.6
	Region 6		
1.	Mt. Hood	4.83	10
2.	Siskiyou-Siuslaw	4.45	13
3.	Columbia-Olympia	4.98	15
4.	Willamette	4.73	19
5.	Rogue River-Umpqua	3.57	21
6.	Chelan	4.39	24
7.	Umatilla-Ochoco-Whitman	2.39	25
8.	Snoqualmie-Mt. Baker	6.88	27
9.	Wenatchee	7.73	32
10.	Wallowa-Deschutes-Fremont-Malheur	4.52	33
	Region 26,350 miles	4.94	8.8
	Region 2		
1.	Montezuma-Uncompahgre-Gunnison	3.26	16
2.	White River	3.22	22
3.	Grand Mesa-Routt-Black Hills-Medicine Bow	2.25	23
4.	Rio Grande-San Juan	2.70	24
5.	Shoshone-Bighorn	4.53	25
6.	San Isabel-Pike-Arapaho-Roosevelt-Harney	3.25	39
	Region 15,997 miles	3.24	4.8
	Region 3		
1.	Carson-Cibola-Santa Fe	1.98	12
2.	Gila-Apache-Lincoln	3.79	13
3.	Tonto-Coconino-Kaibab-Prescott	3.95	14
4.	Crook-Coronado	3.15	21
	Region 12,391 miles	3.29	8.4

Forest Groups	Estimated man hours per mile per year (weighted)	*Percentage of Error
Region 4		
1. Boise	2.99	11
2. Dixie-Fishlake-Manti	2.08	13
3. Uinta-Wasatch-Ashley	3.24	18
4. Targhee-Cache-Caribou	2.49	20
5. Toiyabe-Humboldt-Minidoka-Nevada	1.54	22
6. Challis-Sawtooth	4.45	23
7. Payette	3.33	21
8. Salmon	4.22	23
9. Teton-Bridger	2.31	23
Region 26,957 miles	3.16	6.3
Region 7		
1. George Washington	2.74	12
2. Jefferson	2.75	15
3. Monongahela	2.61	15
4. White Mountain-Green Mountain-Allegheny	2.89	8
Region 4,205 miles	2.77	6.3
Region 8		
1. Chattahoochee	4.00	16
2. Cherokee	2.38	7
3. Nantahala	3.00	17
4. Pisgah	3.14	19
Region 1,951 miles	3.00	9.1
Region 9		
1. Superior	4.82	16.6
Region 948 miles	4.82	

*Error is calculated from unweighted values, which very closely approximate weighted mean values except in a few instances where mileage in "Easy" and "Difficult" are grossly disproportionate.

Percentage of error means that if another sample of the same size were examined, the estimate for it would be within plus or minus an amount equal to the estimate shown, times the percentage of error shown. For example, on the Kootenai, another sample of the same size selected at random would be expected to fall within the limits of 2.62 ± (2.62 times .13) or 2.62 ± .34 or between 2.28 and 2.96.

ROAD-TRAIL INTENSITY

Group 1

35 forests
Sierra Nevada, and Cascade Ranges, North Idaho and Northwest Montana

Forest	Miles per sq. mi. Road	Trail	Forest	Miles per sq. mi. Road	Trail
Cleveland	1.05	.14	Umpqua	.28	.92
Angeles	.86	.65	Willamette	.21	1.05
San Bernardino	.78	.37	Siuslaw	.63	.24
Los Padres	.33	.71	Mt. Hood	.53	1.05
Sequoia	.30	.75	Columbia	.33	1.03
Sierra	.56	.63	Snoqualmie	.26	.74
Stanislaus	.69	.60	Wenatchee	.34	.96
Eldorado	.71	.82	Chelan	.27	.80
Tahoe	.70	.54	Colville	.48	.66
Plumas	.62	.43	Clearwater	.20	1.16
Lassen	.76	.29	Kootenai	.29	.99
Shasta	.50	.66	Flathead	.10	1.09
Mendocino	.56	.79	Cabinet	.31	1.15
Trinity	.26	.89	*Coeur de'Alene	.82	1.21
Klamath	.35	.38	*Mt. Baker	.10	.48
Siskiyou	.30	.70	*St. Joe	.72	1.31
Rogue River	.50	.68	*Kaniksu	.52	1.26
			*Olympic	.37	.35

Note: Figures for all forests are from Progress Record as of March 1, 1946 when this investigation began. Areas are gross. Road mileage includes both forest development and forest highway but only roads included in the system.

Group 2

13 forests
SW Region 1, NW Region 4, SE Region 6

Forest	Miles per sq. mi. Road	Trail	Forest	Miles per sq. mi. Road	Trail
Modoc	.65	.17	Wallowa	.32	.79
Fremont	.74	.10	Lolo	.20	.80
Deschutes	.60	.18	Nezperce	.33	1.07
Ochoco	.68	.23	Bitterroot	.10	.96
Malheur	.68	.41	Payette	.17	.90
Umatilla	.57	.49	Boise	.24	.60
Whitman	.55	.44			

*Last five forests not used in calculating curve of best fit on account of non-forest land situation and on Mt. Baker the barren areas (topographic and old burn).

Group 3

17 forests
SE Region 1, NW Region 2, Northeast Region 4

Forest	Miles per sq. mi. Road	Trail	Forest	Miles per sq. mi. Road	Trail
Deerlodge	.33	.23	Big Horn	.26	.58
Lewis & Clark	.19	.68	Teton	.10	.48
Helena	.40	.59	Bridger	.14	.82
Beaverhead	.18	35	Targhee	.30	.54
Gallatin	.14	.80	Caribou	.26	.51
Custer	.31	.19	Salmon	.17	.75
Shoshone	.09	.46	Challis	.14	.61
Harney	.76	.01	Sawtooth	.19	.80
			*Black Hills	1.42	.02

Group 4

19 forests
West R-2, NW R-3, SE R-4, Inyo R-5

Forest	Miles per sq. mi. Road	Trail	Forest	Miles per sq. mi. Road	Trail
Inyo	.26	.36	Uncompahgre	.23	.61
Prescott	.60	.42	Montezuma	.39	.48
Coconino	.90	.16	San Juan	.20	.59
Tonto	.32	.43	Ashley	.17	.42
Kaibab	.69	.08	Wasatch	.21	.62
Routt	.20	.42	Uinta	.29	.69
Arapaho	.26	.44	Manti	.31	.51
White River	.17	.70	Fishlake	.19	.43
Grand Mesa	.21	.46	Dixie	.25	.35
Gunnison	.21	.61			

Group 5

16 forests
E Region 2, E Region 3

Forest	Miles per. sq. mi. Road	Trail	Forest	Miles per sq. mi. Road	Trail
Sitgreaves	.95	.00	San Isabel	.23	.44
Crook	.43	.58	Harney	.76	.01
Coronado	.67	.43	Roosevelt	.39	.43
Apache	.45	.29	Medicine Bow	.33	.43
Gila	.38	.51	Nebraska	.83	.00
Cibola	.70	.24	Pike	.47	.18
Lincoln	.70	.20	*Santa Fe	.56	.75
Rio Grande	.14	.63	*Carson	.68	.57

*Not used in curve calculation.

Group 6

5 forests
Great American Desert

Forest	Miles per sq. mi. Road	Trail
Cache	0.23	0.22
Humboldt	0.15	0.23
Minidoka	0.34	0.16
Nevada	0.14	0.25
Toiyabe	0.21	0.27

* * * *

A METHOD FOR ESTIMATING TOTAL TRAIL MILEAGE FROM MEASURED SAMPLES

Very little trail mileage, except in Regions 1 and 6, has ever been measured. Mileage by ranger districts, forests and regions is therefore an estimate. None of the mileage examined was measured in the course of the work, but some tests were made beforehand against measured distances, both walking and riding, and some skill was developed in estimating. The field examination and estimates of distance indicated that record mileages not measured were almost invariably over-estimated and often grossly so. Dealing with a problem without knowing its magnitude is not a very satisfactory or businesslike situation and some regions have indicated they propose to make a project of measuring all trail mileage.

It would probably cost from $1.00 to $1.50 per mile to measure trail distances. Actually there is no necessity for measuring all mileage or even a very large percent of it to get a very close estimate, correct within a stated limit of error. (There may be other reasons for measuring and marking miles).

Stated briefly the general plan to get such an estimate is:

1. Classify all the trails on a forest as follows:
   (a) Those on which there is a very large difference between map distance and actual distance.
   (b) Those on which there is little difference between map distance and actual distance.
   (c) An intermediate group on which there is a moderate difference between map distance and actual distance.
2. Measure on the ground a few sections of each of these three classes, selected at random to insure against bias.
3. Analyze result for error of estimate and to find out whether sample is large enough. If not, how much additional measurement is required to get results within specified limit of error.

The plan is outlined in more detail as follows:

1. Using the largest scale map available for the whole forest and showing all trails, classify each trail in the following manner:

   (a) All trails or sections of trail on which actual distance is estimated to be twice as much or more as map distance. This would probably be a small part of the total. Show in red.

   (b) All trails or sections of trail on which actual distance is estimated to be 1⅓ to 2 times as much as map distance. For much of the western regions this class would include a substantial part of the total. Show in green.

   (c) All trails or sections of trail on which actual distance is estimated to be 1 to 1½ times as much as map distance. This would be a fairly large part of the total. Show in brown.

The colors should not obscure the map symbol.

2. Estimate with dividers or map measure the total map mileage in each of the above classes. The purpose of this breakdown is to insure that samples be selected proportional to the magnitude of the classes. As an example, assume a total mileage of 1000 on a forest divided by classes (as above), as follows: 1(a) 200, 1(b) 300, 1(c) 500. Also assume that 5% of the mileage (or 50) will be measured. Then if the samples are to be selected properly, 5% of 200 miles or 10 would be in class 1(a) as described above; 15 would be in class 1(b) and 25 would be in class 1(c).

3. This step is one of the most important in such a scheme. Its purpose is to eliminate bias or prejudice in selecting the specific miles to be measured. Select on the map, mark and designate by number, short samples (say not less than about 3 miles and not more than 5 miles in length - preferably as near 4 miles in length as possible), with both ends indicated by some definite feature on the map such as a stream crossing, a lookout, a trail junction, etc., between which it is possible to step off the distance with dividers. Assuming the same number of samples finally to be measured as outlined above 3 in 1(a), 4 in 1(b) and 7 in 1(c) not less than three times these numbers should be selected on the map. This is to allow chance to operate in selecting the ones that will finally be used for a test. These should be well scattered by ranger districts.

4. Again assuming for example that 3 x 3 = 9 or more have been selected for 1(a), number them consecutively, and also make corresponding numbers on separate slips of paper from which 3 are drawn at random. These three are then tabulated in the following manner and eventually are measured on the ground:

No. and Name of Sample	Scaled Length-Mi.	Measured Length-Mi.	Diff. (Mi.)	% of Diff. from Scaled Lgth.
Class 1(a)				
1. Baldy to Trail Cr.				
2. Red Butte to Horse Cr.				
etc., etc. with similar entries for class 1(b) & 1(c) separately				

Having derived these correction factors it is readily seen how they should be applied to obtain an estimate of the true mileage.

Drawings would be made in the same manner for the other classes.

This is the complete preliminary work and is estimated to require no more than two days' time of one man if he is familiar with all the trails on a forest.

Should any region decide to try out this method, it is suggested it be tried first on the basis of a 10% sample of all the trails on one forest. The data would be carefully analyzed to see how much less than 10% would supply an estimate within a specified limit of error. Afterward the method could be applied to all forests with pretty definite assurance that no unnecessary work would be done.

5. The selected samples may be measured with a bicycle wheel with a meter device or by chaining. If chaining is done, the chain should be allowed to lie on the ground following the sinuousities of the trail rather than being pulled taut or into a straight line. Measurements would begin exactly at the junction or other point definitely identified on the map as one terminus and extend to the other terminus similarly indicated on the map.
6. The simplest calculation would require setting up the derived data in the following form:

Miles	% of error class	Product	Diff. from mean	Diff. squared	Diff. squared times No. of Miles
2.4	0-10				
4.6	11-20				
12.2	21-30				
20.1	31-40				
etc.					
etc.					

Two values result from these calculations which show the dependability or error of the mean estimate. Refinements or deviations from this calculation may be desirable depending on the actual field data. They would add little to the job of analyzing.

7. A test in 1947 by this method, in which 6.52% of the mileage on one forest (91 miles) was measured, indicated that the error could not exceed 5.2% and that if the same were done on all the forests in the region, the regional estimate so obtained would be correct within 0.2% of the true figure.

* * * * *

USE PER MONTH AND MAINTENANCE COST
(Benefit Versus Cost)
Region 1 - 4 Months Season

These tables are intended to furnish some idea of the mileage of trail that is costing more to maintain than the evaluated use of the trail. Time is valued at $1.15 per hour for all use, whether man or beast. Obviously, the time of an animal is worth much less, which results in showing a smaller amount of questionable mileage than if a true value were placed on time of an animal.

For purposes of this comparison it was assumed that unless there would be a saving in time of 15 minutes per mile on a trail versus cross-country there would be no need for a trail in any case. The mileage below and left of the zigzag lines in the tables which follow are those which, in effect, are failing to pay their way, as evaluated time saving is less than annual maintenance cost.

These figures are only a rough indicator. A weakness of this line of reasoning is that some of the miles indicated as being in the questionable class are isolated high-maintenance-cost miles in projects that otherwise may be maintained for a more moderate amount.

Offsetting this is the fact that this excludes any consideration of depreciation of and interest on the original investment which would make an even less favorable picture. These items are not considered, since an investment already made is "water over the dam" and therefore a cost whether the facility is abandoned or continued. As examples, with the cost of trail construction estimated on the average to be about $325 per mile in Regions 1 and 3 and about $525 per mile in Region 5, the annual cost chargeable to obsolescence (25 years) and interest (2%) would be about $19.50 per mile per year in Regions 1 and 3 and $31.50 in Region 5, or two to three time annual maintenance cost per mile on the average. These figures are shown here not as an indication of what annual cost per mile for these items is on the present system, which was constructed for a fraction of present-day cost, but rather to give a general indication

of what annual cost per mile will be for any projects that may be constructed in the future. Actually it may be even much higher than this, because any miles constructed in the future may very well be those that have heretofore been too expensive and therefore have been postponed.

The table follows:

USE BY ANNUAL MAINTENANCE COST
(Benefit - Cost)
Region 1

Average Estimated Cost per Mi. per Year to Maintain	Miles Examined by Use — Average Number of Persons or Animals per Month								
	1	5	10	25	50	100	150	200	Total
$ 2	92	118	65	74	67	38	17	29	500
6	63	88	53	61	40	24	15	22	366
10	43	41	23	52	21	18	8	17	223
14	20	17	10	15	11	3	6	7	89
18	9	5	2	7	4	6	--	6	39
25	2	1	2	6	2	1	1	4	19
35	--	--	1	2	1	--	--	3	7
45	--	--	1	--	1	--	8	1	11
75	--	--	--	--	--	--	3	2	5
	Region 2 (4 Months Season)								
2	--	41	4	88	28	42	5	25	233
6	--	7	4	40	18	45	1	29	144
10	--	4	1	25	4	21	2	18	75
14	--	1	1	7	2	4	2	14	31
18	--	--	--	--	2	1	--	7	10
25	--	--	--	--	--	1	--	3	4
35	--	--	--	--	--	2	--	2	4
45	--	--	--	--	--	1	--	--	1
	Region 3 (6 Months Season)								
2	37	51	34	56	37	10	--	23	238
6	22	16	17	36	1	4	--	9	105
10	4	12	23	50	3	--	--	6	98
14	--	4	5	10	1	3	--	1	24
18	--	--	6	7	--	--	--	--	13
25	--	--	--	1	--	--	--	2	3
									481
	Region 4 (5 Months Season)								
2	19	68	67	87	48	51	3	49	392
6	8	18	23	57	27	41	3	25	202
10	7	4	32	34	25	9	--	20	131
14	2	5	2	14	11	4	--	7	45
18	--	3	--	3	6	--	--	12	24
25	--	--	--	4	2	--	2	7	15
35	--	1	--	2	--	1	--	6	10
45	--	--	--	--	--	--	--	--	--
75	--	--	--	--	--	--	--	1	1

Average Estimated Cost per Mi. per Year to Maintain	Miles Examined by Use — Average Number of Persons or Animals per Month								
	1	5	10	25	50	100	150	200	Total
Region 5 (5 Months Season)									
$ 2	42	37	13	44	7	6	3	11	163
6	63	53	21	77	7	17	24	--	262
10	41	22	20	39	8	18	1	23	172
14	13	6	7	27	6	7	11	--	77
18	2	4	8	12	5	7	--	8	46
25	5	1	5	7	6	1	--	5	30
35	3	2	--	7	3	--	--	3	18
45	--	1	--	2	1	1	--	--	5
75	--	--	--	2	--	--	--	4	6
Region 6 (5 Months Season)									
2	45	36	14	35	11	14	6	18	179
6	23	55	31	52	16	12	1	33	223
10	15	59	28	39	19	16	6	38	220
14	11	21	4	21	14	15	--	18	104
18	2	4	3	7	5	5	--	12	38
25	--	4	--	3	6	4	--	14	31
35	--	--	1	1	7	1	--	11	21
45	--	--	1	1	3	1	--	3	9
75	--	--	--	2	--	1	--	1	4
Region 7 (6 Months Season)									
2	7	14	11	17	3	--	--	--	52
6	--	7	11	47	4	1	--	1	71
10	--	--	--	8	4	--	--	--	12
Region 8 (6 Months Season)									
2	37	21	19	10	10	6	--	--	103
6	28	16	15	33	1	13	1	--	107
10	1	--	9	17	7	6	1	1	42
14	--	--	4	3	--	--	--	--	7

Summed up, these tables raise a question of whether the following mileage and percentage of the total trail system at a minimum can be economically justified:

Region	Miles in Question	Total Mileage Examined	Percentage in Question
1	399	1,259	31.7
2	13	502	2.6
3	85	482	17.6
4	49	820	6.0
5	222	779	28.5
6	192	829	23.2
7&8	36	394	9.1
9	Not available		

WAGE SCALES
C.Y. 1947
(As reported in response to Circ. E-3292)

Region	Average wage per hr.		% of work by		Weighted Average wage per hr.
	Guards	Laborers	Guards	Laborers	
1	$ 1.21	$ 1.10	46	54	$ 1.15
2	1.14	.85	5	95	.86
3	.90	.80	7	93	.81
4	1.17	.92	72	28	1.10
5	1.15	1.04	25	75	1.07
6	1.19	1.04	60	40	1.13
7	1.12	.79	41	59	.93
8	1.05	.63	31	69	.76
9	1.12	.85	5	95	.86

* * * *

Maintenance Cost Adjusted to Wage Scales

This study indicates that about 5/6 of current trail maintenance cost is for labor. The original estimate was for time evaluated at $1.15 per hr. which we had found in a preliminary way to be an approximation of the 1946 average wage scale in the Western regions with the largest amount of trail mileage. The adjustments in the following table are arrived at in the following manner for regions that differ from $1.15 per hr: 1/6 of the original estimate is correct as is. The other 5/6 is corrected by multiplying it by the 1946 regional wage scale, divided by $1.15. The sum of the two is the adjusted scale which follows:

Region	Maintenance Estimate Per Mile	
	@ 1.15 per hr.	@ 1947 wage scale
1	$ 9.96	$ 9.96
2	6.98	5.51
3	7.35	5.54
4	7.33	7.06
5	10.88	10.25
6	11.20	11.04
7	6.14	5.16
8	6.63	4.75
9	12.57	9.93

ESTIMATE of BETTERMENT

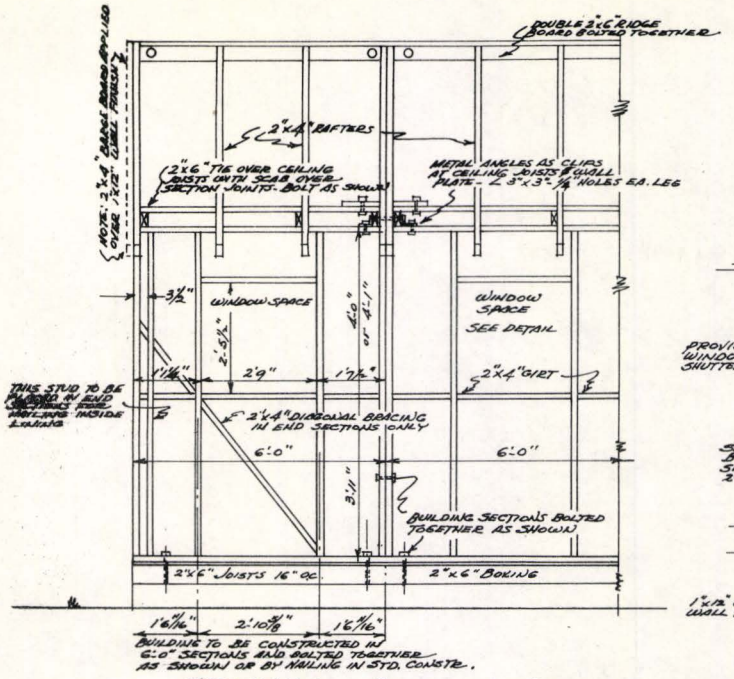
Region	Estimate Per Mile (All Mileage*)	Mileage to be Bettered	Estimated % of mileage Needing Betterment
1	$ 7.55	$ 44.51	$ 14.50
2	25.09	11.54	60.50
3	22.14	81.32	21.40
4	22.91	13.45	63.00
5	27.98	68.17	29.10
6	19.46	24.77	44.00
7	4.74	39.56	11.70
8	4.74	39.56	11.70
9	--	--	--

* * * *

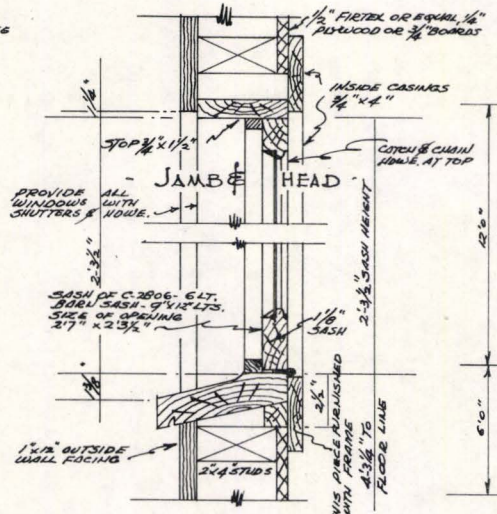
ESTIMATE of CONSTRUCTION COST

Region	Estimated Man Days per mile
1	24.03
2	30.00
3	23.25
4	26.21
5	39.53
6	47.93
7	31.74
8	30.63
9	69.71

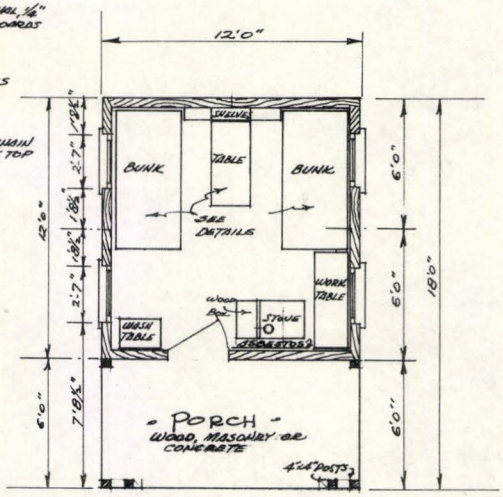
The two preceding tables are nothing more than the roughest sort of index and do not appear entirely logical or reasonable even to the men who collected them. Some of the differences that at a glance appear inconsistent are doubtless due to errors in sampling, sample mileage not having been selected with either of these items in mind. Further, it is easy to get a 100% spread in betterment depending on the amount of "sand papering" that the estimator has in mind. To a less extent the same is true of construction.


DOUBLE 2"x6" RIDGE BOARD BOLTED TOGETHER
2"x4" RAFTERS
(2"x6" TIE OVER CEILING JOISTS WITH SCAB OVER SECTION JOINTS - BOLT AS SHOWN)
METAL ANGLES AS CLIPS AT CEILING JOISTS & WALL PLATE - 2 3"x3" - 1/4 HOLES EA. LEG
WINDOW SPACE
WINDOW SPACE SEE DETAIL
2"x4" GIRT
2"x4" DIAGONAL BRACING IN END SECTIONS ONLY
BUILDING SECTIONS BOLTED TOGETHER AS SHOWN
2"x6" JOISTS 16" OC.
2"x6" BOXING
BUILDING TO BE CONSTRUCTED IN 6'-0" SECTIONS AND BOLTED TOGETHER AS SHOWN OR BY NAILING IN STD. CONSTR.

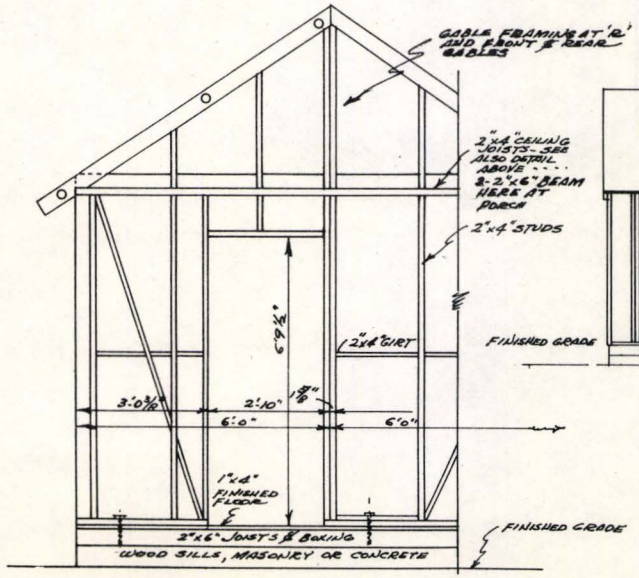
· FRAMING SIDE ELEVATION ·
SCALE 1/2" = 1'-0"


1/2" FIRTEX OR EQUAL, 1/4" PLYWOOD OR 3/4" BOARDS
INSIDE CASINGS 3/4" x 4"
TOP 3/4" x 1 1/2"
CATCH & CHAIN HOOK AT TOP
JAMB & HEAD
PROVIDE ALL WINDOWS WITH SHUTTERS & HOOKS
SASH OF C-2806-6 LT. DBL. SASH - 9" x 12" LTS. SIZE OF OPENING 21" x 23 1/2"
1 1/8" SASH
2'-3 1/2" SASH HEIGHT
1"x12" OUTSIDE WALL FACING
2"x4" STUDS
THIS PIECE ADJUSTED WITH FRAME 4'-3 3/4" TO FLOOR LINE

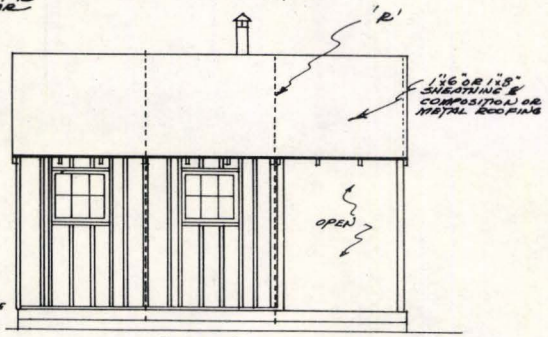
· SILL ·
WINDOW DETAILS ·
SCALE 3" = 1'-0"



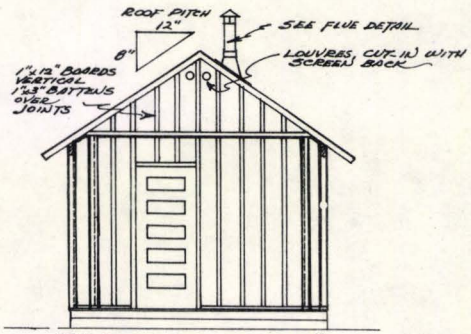
· FLOOR PLAN ·
SCALE 1/4" = 1FT.



· PART ELEVATION · END WALL ·
· FRAMING ·
SCALE 1/2" = 1'-0"



· SIDE ELEVATION ·
SCALE 1/4" = 1'-0"
(NOTE: OTHER SIDE SIMILAR)



· END ELEVATION ·
SCALE 1/4" = 1'-0"
(NOTE: OTHER END SIMILAR LESS DOOR & PORCH)

ESTIMATE

Materials	$575
Labor	300
Furnishings (Stoves, mattresses, chairs, etc).	75
Transportation°	200
	$1,150

°Transportation costs vary with distance from a road and means of transportation to isolated areas.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

REGION FOUR — A.L. ANDERSON, REGIONAL ENGINEER

· TRAIL SHELTER CABIN ·

PLAN R-4-5 126 G-1-HT — SHEET 1 OF
DESIGNED G.L. NICHOLS — DRAWN G.L.N. — TRACED G.L.N.
SCALE AS SHOWN — CHECKED G.L.N.
APPROVED — DATE
APPROVED — DATE